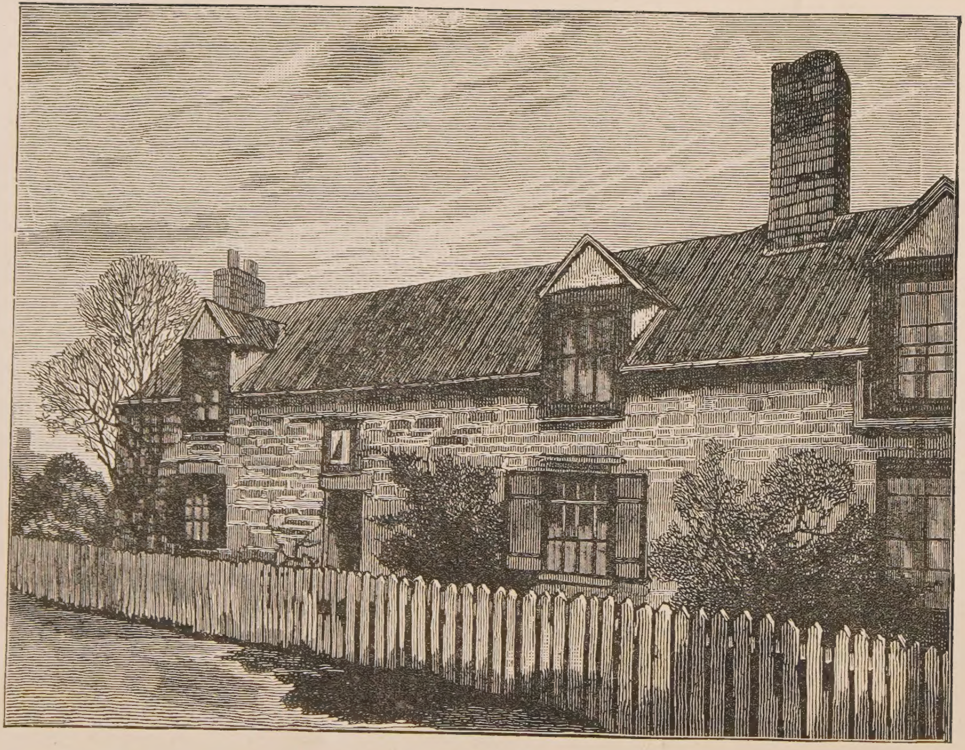

Stephenson's Cottage at Killingworth.

MEMORABLE MEN OF THE NINETEENTH CENTURY.

VI.

THE STEPHENSONS

AND OTHER

RAILWAY PIONEERS.

BY

J. F. LAYSON.

JOHN M'CREADY,

GLASGOW AND SYDNEY.

Preface.

AS the records of human actions form the most important part of a country's history, so the labours of English Engineers furnish the best materials for a narrative of the promotion and progress of the Railway System. In the following biographical sketches an attempt has been made to group together the leading incidents in the lives of Memorable Engineers of the Nineteenth Century, so as to give the reader a concise recital of the events that contributed to the birth and growth, conception and maturity, of the most prominent enterprise of modern times. Should it be felt that some matters have not received such a full treatment as either the importance of the subjects or their bearing upon any particular career would have warranted, a reason for the apparent omission may be found in the circumstance that occurrences which have been passed over in one connection may have received fairer usage in another. The author desires to acknowledge his indebtedness to others who have written more copiously on the History of the Railway, the Invention of the Loco-

motive, and the lives of the respective Engineers. Of such authors the following may be named:—Nicholas Wood, O. D. Hedley, Samuel Smiles, J. C. Jeaffreson, William Pole, and Francis Trevithick.

To realise to any extent the value of the benefits which the Pioneers of the Railway System have conferred upon our country and the world, we have only to imagine what effects would be likely to follow the sudden and complete abandonment of the iron highway as a channel of communication to the great centres of labour and population. Trade and commerce would be arrested. Industry would be paralysed. The present numbers of our countrymen could not be sustained. While some species of property would be reduced to a fraction of their value, others would be rendered worthless. The large towns and cities would be similarly affected as by a siege, and famine would decimate their inhabitants. Existing schemes for the amelioration of human want and misery would be eclipsed by the deeper suffering and more urgent need that would prevail. These and other calamities would in all probability follow the destruction of our iron roads and the extinction of the iron-horse. Familiarity with the Locomotive and the Rail has a tendency to dull the appreciation with which both should be regarded; for they have become necessary elements in the advanced progress of nations.

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CHAPTER I.

THE WAGGON, THE COACH, AND THE RAILWAY.

TWO hundred and forty years ago a visit was paid to a French madhouse by an English nobleman, the Marquis of Worcester. As he passed through the wards containing the cages wherein the most unfortunate of their species were confined, like so many wild animals, the attendant who accompanied him described the various hallucinations peculiar to the inmates of that abode of the hopeless. As they approached one of the caged cells, the steps of the visitor were suddenly arrested by a pitiful cry and the terrible appearance of a man whose cadaverous and care-worn countenance peered through the massive bars which his thin, bloodless hands tremulously clutched. The ashy lips, from which the cry had proceeded, again parted, and a voice, hoarse and husky, but fierce in its earnestness, exclaimed, "I am not a madman. I am the discoverer of a power of incalculable moment to mankind."

"What has this man discovered?" inquired the Marquis.

"A mere trifle," the keeper answered derisively; "but he wrote a book about it, nevertheless. Why, you would never guess what the discovery was—to use the steam of boiling water for the navigation of ships, the driving of carriages, and

a host of other miracles which are equally incapable of performance."

Such was the fate of him who, in all probability, first projected the idea of steam locomotion—Solomon de Caus, a native of Normandy—and such the reception which was given to a discovery calculated to confer stupendous benefits, not only upon France, but the world. The age was not, however, propitious to scientific or mechanical research. Supineness in the Court, and superstition in the Church, together with the antagonism of officials towards anything which took the shape of innovation, conspired to hold back from society for a time the advantages which have since attended the construction of the steam engine.

Confident in the soundness of his conclusions, poor Solomon de Caus had laid a description of his plans before the King of France; but the mind of the monarch was not fitted to deal with such complicated details as were therein presented, and the readiest way to dispose of the matter was to treat the Norman genius and his discovery with contempt! The influence of a prince of the Church was next solicited to favour the designs of the obscure student of Nature and her forces; but, exasperated by repeated and urgent appeals, the Cardinal consigned his importunate suppliant to the confines of a madhouse, and Solomon de Caus and his premature project were lost to his country and mankind. A similar reward might also have been meted to the foster-father of the locomotive and the railway, had the innate determination and energy of George Stephenson been less dogged and less dauntless than the event proved these to be.

Material improvements in the ordinary conditions of life are but seldom to be attributed to accidental circumstances. Mighty and beneficial changes in the surroundings of human existence have resulted from individual effort, and the patient, persistent pursuit of progress and proficiency. And yet, in spite of the truism, men are generally averse to

encounter minor evils, even when major advantages are anticipated to follow a contemplated alteration in the established customs, methods, and manners of a people. The means which are still adopted for travelling purposes by different nations afford ample illustration of man's natural repugnance to that which promises to interfere with settled usage. Individuals had to do battle for the institution of the stage coach in the seventeenth century, as well as for the formation of public railways, and the adoption of the locomotive, in the nineteenth. Happily the champions of progress in both instances were successful.

Till towards the close of the sixteenth century English modes of transit were of a very primitive character. King Alfred's State-carriage has been described as bearing a striking resemblance to a farmer's waggon. No doubt our modern ideas of kingly dignity would receive a palpable shock were a successor of that good monarch to be found travelling now in a similar vehicle, and in the act of goading a team of oxen by the aid of a long stick barbed with iron, as depicted by the artist and the historian. However, we have no reason to think that Alfred appeared to his dutiful subjects as otherwise than dignified and happy, when thus seen riding in his uncouth and rumbling equipage.

In course of time, what had been the exclusive property of the highest personage in the State, came to be offered for hire to all who could pay for the luxury, or were too timid to mount a horse; until, in the reign of Elizabeth, the waggon, as a royal equipage, was supplanted by the coach, which had been imported by the Queen from Holland. To ensure as much safety as might reasonably be expected from the deplorable condition of the roads, a coachman of experience was also engaged in that country. This Dutch progenitor of the British race of Jehu, and his joint importation, formed important additions to the regal consequence and grandeur of the virgin Queen. The State-carriage in

which Her present Majesty occasionally proceeds to the opening of Parliament was constructed for the use of George III. upon his accession to the throne, and is a slightly modernised copy of that in which Elizabeth made journeys to various parts of her kingdom, to the consternation of horses and the bewilderment of their riders.

Stage-coaches for the conveyance of those who desired to travel expeditiously were not established in this country until the year 1657, although private carriages had been in use for sixty years previous to the introduction of coaches designed for public hire; and, for a considerable time after the latter had become a necessity to their patrons, the old lumbering waggon, with its six horses and usual pace of three miles an hour, continued to hold a high place in the estimation of the English traveller. One reason for this was to be found in the very imperfect condition of the roads. Tedious as the rate of progression may have been, travelling by the antiquated means of a stage-waggon in those days was more suited to the neglected highways and the tastes of the people, than by the lighter, and consequently less safe, rival which was struggling slowly into public favour. Some idea of the distaste with which the stage-coach was at first regarded may be conceived from the suggestion of a writer who published a pamphlet in the year 1673. He says: "The multitude of stage-coaches and caravans travelling on the roads might all, or most of them, be suppressed, especially those within forty, fifty, or sixty miles of London." Feeling that his covert advice was not likely to be adopted, however, the author slightly moderates his tone, and gravely proposes that the number of stage-coaches should not exceed the proportion of one vehicle to each county town; that the coaches should individually make one double-journey weekly, returning with the same horses with which they set out; and that the rate of travelling should be limited to thirty miles daily in summer, and twenty-five in winter. The arguments

George Stephenson.

adduced in favour of this series of propositions are not more ludicrous than some of the objections which were raised against the railway proposals of George Stephenson, in the year 1825! Three reasons are given in support of the assertion that stage-coaches were most mischievous institutions. In the first place, they tended to destroy the breed of good horses, and conduced to careless horsemanship; secondly, they hindered the training and employment of watermen, from which class the country largely derived its supply of seamen; and thirdly, they exerted a prejudicial influence upon the Imperial revenue. It is pleasing to note that the much-maligned medium of transit survived not only this attack, but others also of a similar character.

Early in the reign of William III. the stage-coach had arrived at a period in its history when its promoters might treat with comparative contempt the railings of its opponents. The opinion of a traveller, given in the year 1691, may be adduced in illustration:—"Here one may be transported, without over-violent motion, and sheltered from the influence of the air, to the most noted places in England, with so much speed, that some of these coaches will reach *above fifty miles on a summer day!* That little improvement had been effected in the rate of progression during the succeeding seventy-five years, we learn from the experience of John Scott, afterwards Lord Eldon, who in the year 1766 travelled from Newcastle-upon-Tyne to London in a 'Fly;' so designated on account of its *speed.* He who became a famous Lord Chancellor spent *nearly four days on the road.* The same distance may now be covered in *six or seven hours* by rail! Some old advertisements relating to coach journeys have been preserved; the following offers an illustration of the tediousness of a trip in 1742. It is taken from *Walker's Birmingham Newspaper*, of the 12th April in that year, and the public announcement is made that "the Lichfield and Birmingham Stage Coach set out this morning (Monday)

from the Rose Inn, at Holborn Bridge, London, and will be at the house of Mr. Francis Cox, the Angel and Hen and Chickens, in the high town of Birmingham, on Wednesday next, to dinner, and goes the same afternoon to Lichfield; and returns to Birmingham on Thursday morning, to breakfast, and gets to London on Saturday night; and so will continue every week regularly." A journey from London to Birmingham, which then occupied nearly three days, may now be accomplished *in three hours!*

In the old coaching days considerable interest was attached to the journey of a few hundred miles. The merits, or demerits, of rival conveyances had sometimes to be studied, and preference given to the coach that was supposed to have the smaller number of accidents recorded to its disparagement. The intending traveller had usually to adjust his earthly affairs before starting; besides making his will, if that necessary qualification to a peaceful departure from this world had not previously been attained. A painful leave-taking had not only to pass between him and his nearest and dearest ones, but a number of his acquaintances and neighbours had also to be visited and hugged, and not unfrequently public prayer offered for his *safe* return. If the traveller was in comfortable circumstances, he advertised for a companion or two to share his difficulties or dangers, and the extortionate demands of post-boys and innkeepers, besides the heavy hire-charges of a chaise. The character and position of those who offered themselves as travelling companions had to be scrutinised and determined; while the journeys so undertaken frequently began with misgivings and fears, and were brought suddenly to an issue with the fractured skulls and dislocated limbs of the travellers. But a happier era dawned when the practical application and common-sense of Telford and Macadam improved the roads, and so gave encouragement to men of capital and enterprise to construct light and commodious coaches, and to improve

the breed of horses, until at length the English mail coach became famous throughout the world.

Like the stage-coach of the past, the railway of the present is of English origin and growth. It began its career in a very humble manner. Before anything akin to systematic attention had been paid to the roads of the country, or Highway Boards had been devised to that end, pack-horses were used for the conveyance of merchandise, especially when the ground to be traversed was of an undulating nature, and the distance not too great. As the population and its requirements increased, canals were formed to further the interests of trade, and connect the larger centres of industry and wealth. But while these once popular channels of transit may be said to have owed their existence to the general commercial exigencies of the nation, the birth and development of the railway is primarily to be attributed to the need of our coalowners for greater facility in the carriage of the produce of their mines to the riverside wharf. Before the advent of the infant railway, coal was transported from the colliery to the shipping staith in the most primitive fashion; horses, ponies, asses, and mules being utilised for the purpose, and the burdens being carried in sacks or panniers, which were slung across the backs of the animals. Those who have been familiar during their lives with the heavily laden coal-train, consisting of twenty or thirty waggons drawn by a powerful locomotive, cannot adequately realise the difficulties in transit which preceded the laying down of the first line of rails.

The first colliery waggon-ways consisted of rude planks of wood, which were placed upon the tracks in order that the waggons might travel with less resistance than upon the uneven ground. The next step in advance was the addition of wooden rails with a raised rim to keep the waggons on the track. Further improvements were effected by placing thin plates of iron upon the wooden rails, and making

flanged wheels for the waggons; the latter rendering the raised rim or flange upon the rails unnecessary. In course of time, the idea was naturally suggested that rails wholly made of cast-iron possessed advantages over those of a composite character. Cast-iron rails, in turn, gave way before the superiority of malleable iron; and to-day steel rails are required to resist the great strain of the immense traffic which passes over certain portions of the principal lines of the country. At the beginning of the present century, Mr. Benjamin Outram introduced "props" of stone for supporting the joints and ends of rails; and his plan was generally followed in the construction of new colliery "plate-ways." The roads thus formed were known as "Outram roads;" or for brevity, "tram roads." These were the immediate predecessors of public railways; the stone "prop" being superseded by the wooden "sleeper."

Horses were generally used in the haulage of waggons upon the early "plate-ways;" but from time to time other descriptions of propelling power were proposed, tested, and found to be mainly impracticable or totally useless. Various engineers had endeavoured to carry to a successful issue James Watt's design of a locomotive for common roads. Much time, ingenuity, and money were expended over those sanguine but futile attempts to construct a reliable "travelling engine;" numerous experiments were made; many patents were granted. Repeated failures, however, caused the idea of a steam carriage, available for the common highway, to be abandoned by engineers and capitalists as utterly hopeless. Baffled in their endeavours in one direction, engineers turned their attention towards another, and, happily, with greater encouragement and better promise of ultimate success. Trevithick, a native of Cornwall, appears to have been the first to demonstrate the practicability of a union between the locomotive and the railway. Unfortunately for himself, he did not possess the natural qualities

necessary to bring the idea he had conceived to perfection. He was erratic and restless, and lacked the spirit of patient, persevering industry invariably to be found in a successful inventor. It is not surprising, therefore, to find the ingenious originator of the railway locomotive soon taking up other projects, and leaving other men to bring into practical use that which was calculated to enrich his position in life and immortalise his name. In the year 1804, Trevithick constructed a "travelling engine," which was placed on the colliery railway at Merthyr Tydvil, in South Wales. After undergoing repeated experiments and alterations, it was found to be defective in principle, and was in consequence abandoned. An insurmountable difficulty appeared to stand in the way of steam locomotion being applied to the railway. Mechanical engineering being yet in its infancy, it was erroneously supposed that the wheels of a locomotive would turn round without *biting* the rails; or, in other words, that its adhesive power would be insufficient to ensure the propulsion of the machine and its load along the line. Stephenson subsequently proved the fallacy of the fear; but the difficulty, though imaginary, proved a source of much trouble to the early mechanical engineers.

The first locomotive used regularly on a private railway was constructed from the design of Mr. John Blenkinsop, who, in the year 1811, took out a patent for a racked rail, into which the toothed wheel of his locomotive worked when travelling. This engine differed from Trevithick's in having two cylinders—an improvement devised by Mr. Matthew Murray, a mechanical engineer of considerable ability—and, on the 12th August 1812, it began to run on the line which had been laid down between the Middleton Collieries and Leeds; a distance of three-and-a-half miles. About a year afterwards, one of Blenkinsop's locomotives was brought to Coxlodge Colliery, in the neighbourhood of Newcastle-upon-Tyne, and its inauguration there is thus

chronicled in the *Local Records* of John Sykes, under date 2d September 1813:—"An ingenious and highly interesting experiment was performed, in the presence of a vast concourse of spectators, on the railway leading from the collieries of Kenton and Coxlodge, near Newcastle, by the application of a steam engine, constructed by Messrs. Fenton, Murray, and Wood, of Leeds, under the direction of Mr. John Blenkinsop, the patentee, for the purpose of drawing the coal waggons. About one o'clock the new invention was set agoing, having attached to it sixteen chaldron waggons loaded with coals, each waggon, with its contents, weighing four tons or thereabouts; making altogether an aggregate weight little short of seventy tons. Upon a perfectly level road, the machine so charged, it was computed, would travel at the rate of three-and-a-half miles per hour; but in the present instance its speed was short of that, owing, no doubt, to some partial ascents in the railway. Under all the circumstances, it was very highly approved of, and its complete success anticipated."

The toothed rail and its companion-wheel, which were the leading novelties in Blenkinsop's locomotive, never attained such a measure of success as the chronicler prognosticated or the inventor desired. The engine-gear frequently got out of order, and the rail-teeth were rendered defective, through breakage, or the presence of stones upon the line. The partial success of the machine, however, stimulated other engineers in their endeavours to effect further improvements; and, while the history of those efforts undoubtedly furnishes a formidable catalogue of failure, misfortune, and disaster, many germs of excellence were discovered through the thought and labour of several earnest plodders in the field of mechanical experiment and research, which only required the fostering care of a master-genius to fertilise, by removing what was worthless, and preserving all that was advantageous and sound.

From what has been stated regarding the advent of the locomotive, it may readily be conceived that the popular verdict was decidedly adverse to its prolonged existence. It was associated in the public mind with all that was dubious and diabolic, with everything dirty and dangerous. It was clumsy and forbidding in appearance, and, by the steam being allowed to escape at high-pressure, it screamed in a manner the most repulsive and horrible. It impregnated the surrounding atmosphere with sulphurous fumes, and blighted the neighbouring fields with red-hot cinders. It alarmed men and frightened horses with its ear-piercing noises and unwieldy gait. It belched, and hauled, and strained, and jolted, at the rate of two-and-a-half miles per hour. True, it sometimes succeeded in dragging a ponderous weight, but a team of horses had frequently to attend its movements, in anticipation of a break-down, and in order to draw it ingloriously home. Such was the nature of the infant locomotive; and it is not to be wondered at that the unfortunate people who lived near its daily track never heard its distant snorting without regretting that the monster had not been strangled in its birth, or that they dreaded its approach as the bearer of ruin to their property, and possible destruction to themselves. Accidents from the explosion of locomotive boilers, now of rare occurrence, were then comparatively frequent, when we take into account the small number of such engines that were constructed previous to the era of public railways. The following is extracted from Sykes' *Local Records*, under date 31st July 1815, and shows that considerable reason existed for popular prejudice against the extended use of the "travelling engine:"—"A shocking accident happened at Newbottle Colliery, owing to the boiler of the locomotive engine bursting, from being too strongly charged. It was the first trial of the machine, which was intended to draw twenty waggons, and a number of persons had assembled around it

to witness its setting off. The brakesman was dashed to pieces, and another man cut in two, by the fragments of the boiler, and a little boy thrown to a great distance and killed. About fifty others (of whom some died) were most severely scalded and wounded." This and similar disasters tended for a time to shake the faith of even practical men in the ultimate success of the locomotive; while capitalists, who frequently furnished the means for carrying on abortive experiments, stood aghast at the outlay they had repeatedly staked, on the barest chance of receiving any adequate return.

While we may lament the fact that men have thought and worked, ruined their constitutions through excessive application, beggared their families by the total expenditure of their capital, and finally died neglected and unknown, in prosecuting a scheme of universal rather than of selfish interest, we cannot but admire the qualities of energy and determination that reaped for their possessor the harvest for which others had also laboured and toiled. While many of finer temperament and more refined exterior retired from the contest disheartened or beaten, George Stephenson struggled bravely on. He had been trained in a rough school, and had become hardened against the enervating influence of difficulties, and was naturally indifferent to the threatenings of defeat. Possibly he could not lay claim to such genius as was fitted to conceive the grand idea of a locomotive. His bitterest opponent could not but allow that he possessed the shrewdness and ability to discern and develop its capabilities, and the indomitable energy necessary to turn these to practical account. How he effected this momentous result is told in the following pages.

CHAPTER II.

CHILDHOOD AND YOUTH.

A HUNDRED years ago a Northumberland village received a mark of distinction that might well have been coveted by the proudest city in the kingdom. To the small and otherwise uninteresting village of Wylam, on the north bank of the Tyne, belongs the honour of being the birthplace of him who became the first railway engineer, and famous as the foster-father of the locomotive. In the humble home of a colliery fireman, George Stephenson was born on the 9th day of June 1781. The surroundings of his childhood were not calculated to form a favourable starting-point from which to attain distinction in the race of life. Distant about eight miles from Newcastle, the locality of his birth exhibited the usual indications of a neighbourhood whose inhabitants were engaged in the working of iron and the winning of coal. George Stephenson's earliest infancy was associated with cinder-banks, coal-heaps, and blast furnaces.

His paternal grandfather having hailed from beyond the Tweed, George may have inherited from his Scottish lineage some portion at least of that plodding earnestness and untiring application that were such prominent traits in his

disposition, and which gave such a well-defined individuality to his character. His father—old Bob, as he was usually called by his friends and neighbours—had previously lived with his newly-married wife at the neighbouring village of Walbottle. Mrs. Stephenson, whose maiden name was Mabel Carr, was the daughter of a dyer at Ovingham, another Tyneside village; and, while the good woman proved a faithful wife to her husband, and a careful mother to her family of six children, we are warranted in concluding that to her decidedly nervous temperament and somewhat weak constitution, were added a considerable amount of mental energy and will-power, which intellectual characteristics doubtlessly descended to her son George, who was her second child. Robert Stephenson and his wife Mabel were worthy representatives of the class to which they belonged, and in all the changes and struggles which they encountered they appear to have borne a reputation for carefulness, industry, and honesty—all the more honourable to the frugal pair when we reflect upon the straitened circumstances of their early married life, and the moral destitution which at that period so largely prevailed in the mining population of England.

During their residence at Wylam, Robert Stephenson and his family occupied a single room on the ground floor of a house, which still stands, beside what was formerly the bridle post-road between Hexham and the Northern metropolis. The weekly earnings of the bread-winner only amounted to twelve shillings, consequently the poor fireman and his better-half were frequently put to considerable straits while endeavouring honestly to procure the necessaries of life. Education for their children was wholly out of the question. Their small income did not allow an indulgence in luxuries, and the advantages of school attendance were not then so fully apparent to the working classes as these are now, even to the inhabitants of colliery villages.

Thus it happened that Robert and his anxious, thoughtful helpmeet were compelled to concentrate their attention upon absolute and present requirements, and leave such matters as the mental training and future wellbeing of their children to take care of themselves.

George Stephenson's father was naturally of a kind, attractive disposition, a circumstance which not only exerted a powerful influence upon the son's bearing and conduct through life, but brought within its sway, also, the neglected children of the village, to whom "awd Bob" was an authority on all matters pertaining to their daily play, as well as the chosen referee in their occasional disputes. Besides possessing many amiable qualities, Robert was a story-teller of no mean order, and this of itself was sufficient to draw numerous audiences around the furnace of the old pumping-engine, for the purpose of hearing the genial fireman detail the adventures of Robinson Crusoe, recite the hairbreadth escape of one of the characters in the *Arabian Nights*, or dilate upon the prowess of some border hero, immortalised in one of the ballads of Northumbria. These deliveries were given with suitable action and expression on the part of the adult, and received with much interest and favour by the childish auditory. Not unfrequently did it happen that the narrator's stock of romances became exhausted. In such emergencies he never hesitated to draw upon his own imagination for incidents which were likely to please the little folks. Like many of his class, Bob had a great partiality for birds and animals. He took a peculiar pleasure in watching the growth of nestlings until they were nearly able to fly, when he would secure one of the finer birds and bear it triumphantly away. In these bird-nesting excursions he was sometimes accompanied by one of his olive branches; and his son George, when he had attained distinction as a railway engineer, remembered the thrilling sensations he experienced when first held in his father's

arms for the purpose of seeing a nest of young songsters, while the parent birds were searching for food.

When George had been advanced from babyhood by the advent of one and then another little stranger into the family circle, he had to take his duly apportioned share of duty and responsibility, which consisted in running on errands, taking his father's dinner to the furnace-house, and keeping children younger than himself from getting in the way of the coal waggons, as these were drawn by horses along the old wooden tram-road immediately in front of the family domicile. Thus passed the first eight years of George Stephenson's life, without the boy having learned the alphabet of his mother-tongue, and having received no other mental training than such as might be imparted through the medium of his father's fireside tales, the observation of the habits of his father's tame robins, or by watching the movements of the wheezy old pumping-engine at the colliery, and the jolting of the chaldron waggons on the old railway.

The coal becoming exhausted at Wylam Colliery, Robert and his family removed to Dewley Burn, where he obtained employment as a fireman. Though still but a child, George was now expected to do something towards his own livelihood, and a post was soon found for him as a cow-herd on the farm of a widow, named Grace Ainslie, at Dewley. George's mistress had the privilege of grazing her cows along the sides of the waggon-way, and it was young Stephenson's care to prevent the animals from coming in contact with the waggons, and from trespassing upon neighbouring and forbidden pasturage. The boy received twopence a day for his services; and as he was continually in the open fields, his employment may be considered as having been more recreative than laborious. With many spare hours on his hands, he now revelled in healthy out-door amusements; and, while not forgetting his father's favourite pastime of bird-nesting, and following the same whenever

STREET HOUSE, WYLAM, THE BIRTHPLACE OF GEORGE STEPHENSON.—*Page* 21.

opportunity offered, he now gave evidence of that latent mechanical genius which was destined to achieve fame for himself, and to confer incalculable benefits upon future generations.

Along with a young companion, named Thirlwall, George devoted much boyish ingenuity in constructing models of water-mills, which he put to practical test in the small streams which abounded in the marshy neighbourhood of Mrs. Ainslie's farm, and in erecting miniature pumping-engines and winding-machines. The materials for these mechanical efforts on the part of the young engineers were always at hand in the clay-soil of the locality, and the reeds which grew near Dewley Burn. But a start having been made in wage-earning by George, he never allowed mere recreation to hinder his chance of advancement. To get on in the world was, even at that early age, the desire of the lad; consequently we find him soon starting to hoe turnips, and doing other work about the farm, for which he received the daily remuneration of fourpence. Agricultural labours, however, were uncongenial if not distasteful to him. His greatest ambition was to be employed at the colliery, near the old pumping-engine, and in view of the winding apparatus, with its alternately ascending and descending corves. The wish was soon gratified, as he joined his elder brother as a "picker;" the duties consisting in separating the coal, when it was brought to bank, from stones and other refuse materials. His weekly wages now amounted to three shillings, and a further step in promotion was gained by his being set to drive the gin-horse; a position that carried with it an increase of twopence per day, and which we also find him filling at Black Callerton Colliery shortly afterwards. This pit was distant from Dewley Burn about two miles, across fields, and George was obliged to start from his father's cottage early in the morning, in order to get to work betimes, and to walk home in the

evening when his labours were finished, under all the disadvantages of a rough and sometimes almost impassable road. But he was now a strong, growing lad; and as he trudged along, with bare feet and legs, he was more concerned about the movements of any thrush or blackbird he might see on his way than the inconvenience of "plodging" through the pools, or treading the quagmires that lay in his track. There was not a nest in the hedge-rows between Dewley and Black Callerton into which he had not peeped. The single apartment which served all the purposes of bedroom, kitchen, and parlour to the family, was also made into an aviary, through the bird-nesting proclivities of George and his father; blackbirds being especially the favourites of the boy. Unconfined by cages, the feathered youngsters were soon taught to feed from the hand, and fly about the cottage; not confining their flights to the interior. One blackbird, in particular, became so tame, and was so attached to the home where it had been reared, that for some years it never failed to return after having spent the pairing-season in the woods with a mate. After flying in, out, and about the doors during the day, it usually took up a roosting attitude near the sleeping forms of its human friends at night. Besides indulging his great liking for birds, George prided himself on the possession and superiority of his stock of tame rabbits, kept in a house of which he had himself been the architect and builder.

He had from his early childhood acquired an absorbing interest in colliery engines and all their belongings. When but a very small urchin, nothing gave him greater pleasure than to watch the motion of the pumping machine at Wylam, as it wheezed, and creaked, and moaned; while he listened to the plunge of the pump far down into the bowels of the earth with feelings of wonder and curiosity. Throughout his boyhood he considered the position of an engineman to be the end and aim to which his whole

energies should be devoted; and when, about the age of fourteen, he was taken on as assistant fireman to his father at Dewley, he gave expression to his unbounded delight, as he was now, he thought, on the high road to the attainment of his ambition. There was only one circumstance, at this period of his life, which caused him to feel at times otherwise than happy, and which served to curb the natural buoyancy of his disposition. It was feared that his age and stature would be barriers in the way of his retaining the situation to which he had been appointed. To prevent such a contingency, the young fireman had recourse to strategy; and whenever the owner of the colliery was on a round of inspection in the neighbourhood of the engine, George invariably kept out of sight, in order that his extreme youth might not be discovered by his employer. By this means he was enabled to retain his position, with its emolument of six shillings a week, until time had given him so much experience in the work that his boyish appearance was not likely to militate against the gratification of his wish to succeed in the world.

Hard necessity again compelled Robert Stephenson and his family to remove their quarters. The working of the Dewley Burn Pit having ceased through the failure of the coal supply, they removed to Jolly's Close, near to the village of Newburn. The two eldest sons were now both employed as assistant firemen, while the younger ones worked as "wheelers" or "pickers," and the two girls assisted their mother in the duties of the household. Although the father and his four sons were all earning money, we find the family still occupying a single room, the capacity of which, available for the ordinary purposes of living, was much circumscribed by the space occupied by the three low-poled bedsteads upon which the various members of the family slept. To the uninitiated in the usages of colliery life, these domestic arrangements may

appear singular, if not positively indecent. But the Stephensons simply followed a practice which was then too common among their class, and which has, even now, not been completely abolished by improved cottage accommodation in our colliery villages. Besides, the customary day and night "shifts" frequently allow some member of a colliery workman's family to be at work while others of the same household are asleep; and thus are mitigated some of the inconveniences of over-crowding. When George had attained his sixteenth year, he was engaged as a fireman on his own account, at the Mid Mill Pit, also in the neighbourhood of Newburn, but without any increase in his weekly earnings of six shillings. Still, this was a step in a forward direction, and he felt pleasure in the consciousness of increased responsibility.

Although not of a robust constitution, out-door employment and healthy exercise had rendered young Stephenson strong and wiry. He entered into athletic competitions with a will, and his companions had to acknowledge his superiority in many feats of strength and dexterity; such as lifting heavy weights from the ground, or throwing the hammer. He was sober, steady, and industrious to a degree, and so far above many of the young men with whom he associated; but his total want of education kept him down to their level in other respects, and he might have ended his days as a very respectable colliery workman and nothing more, but for his determination to better his condition by application and perseverance in the course he had marked out for himself. He was conscious of his deficiency, arising from the lack of tuition, and he resolved to curtail his enjoyments and learn to read. He also purposed to make himself acquainted with the colliery engine in all its gearing, so that he might be able to fill the post of engineman, towards which he ardently aspired, to his own credit and the advantage of those who in the future

might employ him. This latter resolve he proceeded to carry out at once, while he kept on the outlook for an opportunity to learn the rudiments of his mother tongue. All his information regarding passing events had hitherto been derived from the reading of others, and he longed to be able to be independent in this respect, and to gather knowledge for himself.

When George went to work at the Mid Mill Pit, he formed a friendship which gave an impetus to his opening career as a colliery workman. William Coe, a fireman like himself, soon attracted Stephenson's notice by exhibiting qualities of mind and disposition that were much in harmony with his own; and for the space of two years the youths worked at the same engine fire, united by the ties of a strong attachment to each other. At the end of that time, the pit at Mid Mill being closed, the two friends were sent to Throckley Bridge, where they worked a pumping-engine for some months. Here George received an advance in wages, which rendered him, to use his own words, "a made-man for life." The first receipt of twelve shillings, as a week's pay, was an event of no little importance to him; and he gleefully announced the circumstance to his fellow-workmen who surrounded the foreman's office upon that, to him, memorable Saturday evening. While he was employed at this colliery he still continued to reside with his parents at Jolly's Close, but the Duke of Northumberland's enterprise having proved a failure, another pit was sunk in the interests of his Grace, on land which lay half-a-mile to the west of Newburn Church, and between the waggon-way at Wylam and the Tyne. Robert Stephenson was engaged as fireman for the pumping-engine which had been erected by the Duke's engineer, Robert Hawthorn, at the new colliery; and the old man had the satisfaction of finding that his son George, though little more than seventeen years old, had been appointed engineman, or "plugman,"

under the chief engineer. The title of "plugman" is derived from the engineman's duty to see that the tube of the pump is kept sufficiently plugged when the water at the bottom of the shaft is at a low level, so as to ensure complete suction, by preventing any exposure of the suction-holes to the atmosphere. The son now held a position superior to that of his father; but his success neither inflated him with pride nor caused him to rest satisfied with what he had already acquired. His good fortune, and the reward which had attended his earnest endeavour to discharge his duty as a workman in a conscientious and efficient manner, but served as powerful stimulants to increased exertion and higher attainments.

The engine now became to him as a pet and plaything. It absorbed his undivided attention by day, and occupied a foremost place in his thoughts as he lay awake at night. He never tired of watching it in motion, nor inspected without admiration its various parts when at rest. That he might better study its construction, and know the purposes of its parts, he took the machine to pieces and examined the fittings separately. George Stephenson's engine at the Water Row Pit was always, while under his care, a model for cleanliness and efficiency; the engineer of the colliery being but seldom required to remedy defects. So thoroughly did the young engineman endeavour to master the difficulties which necessarily at first presented themselves to one ignorant of the simplest rules in natural or mechanical science, that in a very short time he had gained such a practical knowledge of the machine as enabled him to give advice and render assistance to men of more advanced years and longer experience in the work, but whose powers of observation and industry were inferior and less decisive than his own. Of such things as treatises on the steam engine he had sometimes heard; but had a book on the subject which occupied so much of his consideration been placed in

his hands, he would have been unable to read the shortest word it contained. He had occasionally picked up stray bits of information from the reading of a friend beside the engine fire; but these in general had more reference to the devastating victories of Napoleon the First than to the bloodless triumphs of Boulton or Watt.

Finding himself, in consequence of his inability to read, at a dead-lock in his pursuit of knowledge, George determined upon attending a night-school. He was now eighteen years of age; scarcely a man, yet doing the work and earning the wages of one. Old and tall as he was, he hesitated not to confess his ignorance, and become as a child in the hands of a preceptor. He had considered the matter in its various aspects, and had concluded that the end he desired was worth all the cost and all the trouble—that the tedious hours to be spent at school and in study at home would fit him to work for better wages, besides enabling him to quench his thirst for information at the fountain-head. For a considerable time his evenings, when not at work, had been occupied in modelling in clay. Sometimes his models were of engines which he had seen; at other times he endeavoured to reproduce, by means of the plastic material, the various parts of engines which had been described to him. In this recreation he had taken considerable delight, since, when a little boy, he had constructed the miniature pumping-machines in the streamlets near Dewley Burn. Now he must, as a rule, give up this source of gratification and enjoyment, go through the drudgery of learning his letters and the multiplication table, and master the initiatory difficulties of pot-hooks and cyphering.

Three nights every week were devoted by George to school attendance, and the remainder of his spare time to study at home. Robert Cowens, a teacher in somewhat poor circumstances at Walbottle, was his first instructor; and, although neither the matter nor the manner of the

lessons would be tolerated in the days of School Boards and taxation for educational purposes, it must be admitted that the homely bearing of the schoolmaster gave confidence to his pupils, and encouraged them in their monotonous studies. Stephenson's fellow-scholars were for the most part young miners, and the sons of labouring men in the neighbourhood, who desired to retrieve some of the opportunities for learning which had been lost to them in their earlier years, either through the poverty or indifference of their parents or their own neglect. Being eager for knowledge, and most diligent as a scholar, George learnt to read in a comparatively short time; and when he had attained the age of nineteen, his progress in the art of writing enabled him to trace slowly the letters of his own name—a feat in his career under poor Robert Cowens of which he was not a little proud. But he grudged the time expended in walking to and from Walbottle; and in the winter of 1799 he was enabled to prosecute his education under more favourable circumstances as to the locality of his school, and considerably better auspices as regarded the qualifications of his teacher. His second schoolmaster was a Scotchman, named Andrew Robertson, who, at the close of the last century, opened a night-school at Newburn, and only a short distance from his home at Jolly's Close. George's kindly nature at first revolted against the thought of being separated in his lessons from him who had first directed his steps in the path of knowledge. Still, the consideration that the Newburn mentor had a good reputation as an arithmetician, and the thought that under the new master he was likely to attain to a higher standard of proficiency, reconciled him to a change which was fraught with many and important advantages.

Andrew Robertson took a great interest in the advancement of his pupil, as well on account of the indomitable industry which the young engineman displayed in his studies,

as for the reason that George soon gave evidence of considerable aptitude for the practice of arithmetic, a science in which the Scotch dominie himself delighted and excelled. Improving every moment of his spare time, George stood by the engine fire and worked out the sums which had been set for him by his master, to whom the well-used slate, upon which the problems and their solutions appeared, was taken each evening, and other work put down for the following day. Endued with a willing mind and untiring zeal, George now made rapid progress, and soon left behind others who had started with him from the same point in the race for knowledge. Nor is the fact of his marked success as a scholar to be wondered at, when we consider the thoroughness of his disposition or the force of his character. He could never leave any task unfinished, or rest satisfied with a partial success. To accomplish all that he knew would benefit himself in the attainment, formed an object to which he directed all the energy of his ardent and unconquerable nature. In seeking to raise himself in the social scale he conferred inestimable favours upon humanity.

CHAPTER III.

THE COLLIERY ENGINEMAN.

GEORGE now felt that he was getting on in the world; but that there was another rung on the ladder of proficiency which he must reach, he had fully and wisely determined. Friendship came to his aid and furthered his design to learn the act of brakeing an engine. The duties of a colliery brakesman are of a monotonous but important nature; those men being invariably selected for the post who have earned for themselves a reputation for punctuality, carefulness, and sobriety during their probationary training as firemen. Being one of the higher kinds of colliery labour, it is comparatively well paid; therefore George had a double motive in seeking to acquire the practice necessary to fit him for taking the position. The envy of other workmen, it is true, conspired for a time to thwart him in his efforts after his own improvement in this particular; but he was able to overcome overt acts of opposition, and to prove his fitness for the work, through the kindness of his friend, William Coe, who had been appointed brakesman of a small winding-machine which had lately been erected for drawing the coal to bank at the Water Row Pit.

William occasionally allowed George to work the brake, and gave him the instruction necessary to qualify him to fill a situation similar to his own. Some of the workmen, however, having objected to this proceeding, and one having even stopped the working of the colliery on this account, the young brakesman, whose friendship for Stephenson had prompted the kindly action, took the earliest opportunity of justifying his own conduct in the view of his superiors. A banksman named Locke would appear to have taken a leading part in opposing William Coe, and in seeking to prevent him from initiating his friend into the secrets of his daily work. Coe resolutely resolved upon bringing the dispute to an issue, however, by calling upon George to take his place at the apparatus, just as the manager, Mr. Nixon, was one day approaching the brake-house. Locke, thus challenged, ceased working, and sat down, with the result that for the time the operations of the colliery ceased. Mr. Nixon having demanded an explanation of the untoward proceeding, was informed by the arbitrary banksman that Stephenson was incompetent to do the work of a brakesman, and falsely added that George was much too clumsy in his movements ever to learn. The manager, shrewdly detecting the jealousy that had prompted the objection, ordered the work to proceed, without calling in question either the wisdom of William Coe in seeking to do a good turn to his friend, or the aptitude of George Stephenson for acquiring an art which was one of the stepping-stones to his career of distinguished usefulness and honour.

The friendship which had been thus tested continued to exist between Coe and Stephenson even after their different fortunes had separated their paths in life; and for at least three years after the incident at the Water Row Colliery the intercourse of the two "marrows" was of the most intimate and cordial nature. After working together in the neighbourhood of Newburn for about three years, they removed

to Black Callerton, where George so gained the confidence of his new employers as to be appointed brakesman at the Dolly Pit. He was now only twenty years old, and the promotion he had attained is the best evidence of his good qualities and character in early manhood.

He still continued an earnest student, and had become an eager searcher after information, especially such as referred to the construction or application of steam engines. His teacher, Andrew Robertson, respected him for his sterling moral qualities, and felt proud of the advancement in learning which George had made under his care; and the poor dominie, finding his night-school likely to be deprived of its most promising scholar, and a general falling-off in the number of his pupils, also removed to Black Callerton Colliery, where he had the satisfaction of ministering further to the educational necessities of one for whom he had conceived an affection almost akin to that of a father.

Up to this period George had always managed to devote some portion of his time to caring for the wants of his feathered friends. He had inherited his father's love for birds and animals; and, like his father, he could command the presence of a number of robins that flew about him at the engine fire, attracted by the bread-crumbs which he daily saved expressly for them. He had found, too, a faithful dumb companion in a dog, whose sagacity was of a high order, and frequently turned to account in bringing his master's dinner. When so engaged, the animal heeded not the snarling of any curs he might meet upon the road, and but rarely was called to defend the possession of the tin can which contained his master's meal. When the pugnaciousness of a canine passer-by was not to be avoided, however, he could give a good account of himself, and the intruder invariably found that he had the worst of it when it came to a matter of determined hostility. Upon the occasion of one of these encounters, George's messenger was only able

to retain the keeping of the tin can: the dinner had been spilt; but the master readily overlooked the loss of a meal, and felt rather proud of the prowess of his dog when he was made aware of the circumstances. But the brakesman's affections were now to be devoted to a worthier object, and his solicitude directed into another channel.

Early marriages formed then, as now, the rule rather than the exception, among the hardy population of Northumbrian colliery villages; and George sought to give practical effect in his nuptials to the custom. He took up his residence in the household of a small farmer at Black Callerton, whose servant soon found favour in the sight of the young, active, and prepossessing lodger, if she had not effected that result previously to her lover being admitted to her daily society at her master's fireside. Fanny Henderson's personal attractions were enough of themselves to draw attention, and to kindle the tender passion in any young man of twenty and her station in life; and when we are informed that to her striking comeliness of form and feature were added the sweetest of tempers, a modest demeanour, kind disposition, and considerable good sense, we cannot wonder that the inherent shrewdness of George Stephenson had discovered in the "farmer's lass" qualities that were congenial to his nature, and a heart that was likely to beat in sympathy with his own.

The carefulness and forethought which guided his actions throughout his career were apparent during the period of his courtship. At a time when young men are generally influenced more by impulse than by reason, George takes thought for the comfort of his future wife and the furnishing of their home in a respectable fashion. His wages now averaged nineteen shillings weekly, but he would add to his income by devoting his spare hours to remunerative labour, and so save money for the comfortable replenishment of a cottage ere he would take the girl he so truly loved to the

altar. Besides, his duties as a brakesman allowed him a considerable amount of time, which he might turn to his own account without interfering with the services demanded by his situation, and these odd times he would utilise rather than pass in listless inaction. He had learned to mend the miner's shoes; he would now try his hand at shoemaking, as well as continue to do the work of a cobbler. The first guinea saved by him from his earnings in this way was a source of great pleasure to him, as well as a stimulus to continue in his course of self-denial and industry. The story has been told how upon a certain occasion he soled the shoes of his sweetheart, and was so elated at the thought of what a capital job he had made of them, that he carried the proofs of his ability as a cobbler, during a Sunday afternoon, after the manner of a lover of the olden time, who was only too happy if fortune threw in his way the glove or handkerchief of his mistress, to keep as a guerdon of his affection and fidelity.

The attachment which had been formed between him and the amiable Fanny Henderson no doubt acted as a safeguard to George against the temptations incident to his station as a colliery workman, and assisted in strengthening his resolution to pursue an honourable and steady course in life. He has been described by his most intimate friend and daily associate at this period as being "a standing example of manly character." At the usual fortnightly saturnalia on pay-day, while his fellow-workmen were, for the most part, drinking at the village inn or engaged in the brutalizing sport of dog-fighting or cock-fighting, George was in the habit of taking his engine to pieces, examining and cleaning the separate parts, and putting all together again, ready for the work of another fortnight, after its pains-taking attendant had received further insight into its mechanism and usefulness.

Some of the young and sport-loving miners might consider

the habits of the steady-going brakesman as being too strait-laced and singular to their taste, and as an evidence of a cowardly and narrow disposition; but George could give what appeared to the average minds of those who were of such an opinion, if occasion required, indubitable proof of the bravery and manliness of his character. A pitman, named Nelson, at Black Callerton, was the terror of the respectable and peace-loving portion of the community. He had earned for himself some notoriety as a pugilist, and to quarrel with him was tantamount to giving him a challenge to fight. George, in the course of his work as a brakesman, having to draw the miners out of the pit at the close of each working "shift," gave some offence to Nelson by the manner of his brakeing the machine one day, while the pugnacious bully was ascending the shaft. With a volley of oaths, as he left the cage at the top, Nelson greeted Stephenson, and made some coarse allusions to what he considered his clumsiness. Defending himself from the charge, George appealed to the other workmen to decide whether it was well-founded or otherwise; but his angry opponent would not have the matter decided by an appeal to any such form of arbitration, and threatened to assault the brakesman. George defied him, and the matter was settled for the time-being by the giving of a challenge by the miner, which was immediately accepted, and a day fixed for the fight. As the news of the projected battle spread through the village, much excitement prevailed. In regard to the ultimate result, there was but one opinion—George would be killed. Although popular sympathy was in his favour, no one could believe that the untrained and studious brakesman was a match for the man who had defeated so many in hard-fought encounters. But the event falsified the general anticipation and fears, and taught the roisterer a salutary lesson. Nelson gave up working in order to keep himself strong and able to demolish his antagonist. Stephenson, however, went

about his daily employment as if nothing unusual was to occur; and, when the appointed evening arrived, he went into the Dolly Pit Field to meet his exultant enemy with all the coolness of a professional pugilist. Stripping off his upper garments, he took up his position for the first round; and, as much by the force of his determination as by the strength of his muscles and the celerity of his movements, severely punished his adversary. The young and inexperienced combatant was soon declared victorious, to the pleasure and satisfaction of the majority of the onlookers. This was his first and last pugilistic battle.

While engaged at Black Callerton he first essayed to be an inventor by turning his attention to what he considered would be an improvement in engine-brakeing. The idea which he sought to embody in a practical form was that of a machine which would be self-reversing in its action; but his models, upon which he had spent some time and patience, were eventually discarded as useless, and he reverted in his spare hours to reading and writing, so that he might become more proficient in these arts. The application which he had devoted to his abortive conception was not, however, wholly devoid of benefit to himself, for the mental training which accompanied the concentration of his thoughts upon the object to be attained contributed to fit him for grappling with more important problems, in the solution of which he was successful. When he had been nearly two years at Black Callerton, the offer was made to him to take charge of the Ballast Hill engine at Willington Quay; a post which carried with it an increased income, and enabled him to become a householder on his own account.

The Ballast Hill at Willington received its name from the material of which it was formed. Before the days of iron-built steam colliers, the craft engaged in carrying coal from the Tyne to London and other ports made their runs to the coaly river in ballast, after discharging their cargoes.

Upon arriving at Willington, from which place large quantities of the Northumberland coal was then shipped, the ballast was taken from the vessels and emptied upon a piece of vacant ground in the vicinity of the Quay. In course of time a huge mound of sand and rubbish was formed, requiring engine-power to raise to the summit the waggons laden with the ballast from the ships. At the foot of this "hill" stood the fixed engine of which Stephenson was appointed the brakesman. By industry and thrift he had saved, what was, to a young man of his calling, a considerable sum of money; and Fanny Henderson agreed to become his wife whenever their future home was ready for her reception.

The ground upon which George's cottage at Willington stood now forms the site of the imposing Stephenson Memorial Schools; and to a humble but withal smartly-furnished room in the upper portion of the two-storied building the newly-wedded pair proceeded, after the marriage ceremony in Newburn Church and a visit had been paid to the infirm father of the bridegroom at Jolly's Close. George and Fanny were married on the 28th day of November 1802; and their mode of conveyance from the parental roof-tree to the bridal home was one commonly adopted on such occasions before the construction of public railways. A neighbouring farmer provided two horses, with saddles and pillions—one animal for the joint accommodation of George and his bride, the other for that of the groomsman and bridesmaid. Thus, for a distance of about fifteen miles, the wedding party travelled, until the cottage at Willington was reached, and the happy couple and their two friends began the work of house-warming.

Comfortably settled with his young wife in his new sphere, George applied himself with unabated energy to self-improvement. He was satisfied that, to ascend still higher upon the social ladder, he must by patient application

qualify himself to hold the more exalted position to which he ardently aspired. He resolved to be something more than a manual worker. By carefully husbanding his spare hours he had succeeded, so far, in educating and raising himself to a point considerably above what he could have hoped for as an illiterate youth of eighteen. He must strive after greater attainments, and deserve further success. That he might understand the laws which ruled the movements of his engine he diligently studied the principles of mechanics while he ever and anon tested, by the aid of models fashioned by his own hands, the soundness of the theories about which he had been reading. He delighted to take up uncommon speculations, in order that he might sift some grains of truth, at least, from their bulk of chaff. Having been informed that several mechanists had tried to put into practical shape the principle of perpetual motion, and had failed in their attempts, George set to work and constructed the model of a machine, the driving-wheel of which was to rotate by the action of quicksilver. The inventor certainly gave self-action to his model, but the "motion" not being "perpetual," he wisely gave up the idea for more profitable pursuits.

Ever fond of studying the larger machinery, with its cog-wheels and cranks, his attention was arrested by a household incident to a more delicate form of mechanism than had hitherto occupied his thoughts or ingenuity. While he was at work one day the chimney of his room took fire, with the result that the apartment became filled with soot and steam, and soaked with the water which had been used by kind but unskilful neighbours in extinguishing the flames. Among the mishaps which followed the disaster was to be reckoned the spoiling of a favourite clock, through the action of the steam and soot upon its wheels. George was speedily employed upon his much-prized timepiece; and his maiden attempt at clock-cleaning proved so successful as to qualify

him, by popular consent, to fill the position of clock-doctor *par excellence* of the locality.

During his stay at Willington Quay he made the acquaintance of one who also became distinguished as a mechanical engineer. William Fairbairn, afterwards President of the British Association, was then working at Percy Main Colliery as an apprentice-engineman. The intercourse of the two workmen ripened into a most close and intimate friendship, and many years after, when each had earned for himself an honoured name and high position, did they remember the pleasant evenings which they had spent in each other's society at Willington. Fairbairn frequently visited at the cottage of his friend, and has spoken of the comfort and tidiness which prevailed therein, under the superintending care of the young housewife, as well as of the industry and heartiness of her husband. Upon many occasions, in order to allow Stephenson to add a little to his income, William took charge of the engine at the Ballast Hill, while the brakesman was assisting in clearing a ship of its ballast at the Quay. George also, at this period, filled up a portion of his bye-hours in last-making, cobbling, and shoemaking labours. At home or abroad he was never idle.

On the 16th day of October 1803, Mrs. Stephenson gave birth to a son, whose name in after years was scarcely less eminent than that of his father. Robert Stephenson, called after his grandfather, brought increased happiness to his parents, and his birth cemented the ties of affection which bound them to each other. As a child, Robert was his father's pride and solace; as a youth, his companion and fellow-student; as a man, his adviser and friend. The power of paternal love and the worth of filial reverence and duty were amply illustrated in the joint-career of the famous father and son.

CHAPTER IV.

THE KILLINGWORTH ENGINE-WRIGHT.

GEORGE STEPHENSON tended the engine at the Willington Ballast Hill for about two years and a half, when he left to fill a similar situation at West Moor Colliery, Killingworth, about six miles to the north of Newcastle-upon-Tyne. It was not without some reluctance that he consented to take this step, for he had been able to add to his pay while at Willington Quay by working at ballast-heaving, as we have seen. However, the consideration that he would again be engaged about a coal mine, in labour to which he had been trained in his youth, as well as the thought that he might still employ his spare time in his new neighbourhood to pecuniary advantage, caused him to decide upon making the change. Accordingly he removed to West Moor early in the year 1805, and entered upon his duties as a colliery brakesman.

Twelve months had scarcely been passed by the devoted couple in their new sphere when death severed their marriage-tie, and brought to the husband the greatest sorrow of his life. The loving wife and gentle mother was suddenly taken from her partner's society and the prattle of her little son, after giving birth to a daughter. The baby lived but a

few months, and George felt as if the light of his hearth and home was thus extinguished for ever. But his was not a disposition to be entirely crushed by bereavement. He had loved his spouse with all the ardour of his earnest, manly nature; and, when the poignancy of his grief had been a little dulled by time and duty, the affection which he had lavished upon poor Fanny Henderson, as a maiden and as a wife, was transferred to her surviving child.

Ere the bitterness of his loss had been assuaged, George was asked to take charge of the engine of a spinning mill, near Montrose, in the north-east of Scotland. Thinking that the change might be useful in giving him an insight into the working of machinery with which he was not yet familiar, as well as being otherwise beneficial by removing him for a time from the scene of his sorrow, he accepted the offer of the gentlemen who were interested in his appointment. After making arrangements for the care and welfare of little Robert, who was to be left at Killingworth, he started out on foot for Montrose, a distance exceeding two hundred miles. During his stay in Scotland he gave some evidence of his ready ingenuity in grappling with practical difficulties. The pumps for supplying water to the works becoming clogged, from the sandy nature of the ground, the engineman adopted an expedient which entirely remedied the evil; while the result showed that he had taken a correct estimate of the connection between a certain cause and its effect in the problem of natural science which he had essayed to solve. By causing the lower end of the pump to work inside a wooden box, twelve feet high, into which the water flowed from the upper portion of the well, the fluid could be drawn free from sand, and the difficulty was thus overcome.

After a year's sojourn at Montrose, George returned to Killingworth, travelling a-foot as on the occasion of his going northwards. Upon reaching West Moor he found

that his parents had been reduced to great poverty and distress, through an accident that had befallen his father while making some repairs on an engine. The face of the old man had been severely scorched and his eyesight hopelessly destroyed. His other sons were almost as poor as himself, and consequently little able to mitigate his affliction. George had, however, saved twenty-eight pounds during his absence, and with a portion of this sum he paid his father's debts and removed his parents from Jolly's Close to his own neighbourhood, where he cared for them in their declining years.

About the year 1808, his prospects became involved in considerable doubt and uncertainty. His own bereavement and his father's misfortune had rendered him distrustful of the future; while the social state of England, thrown off its balance by the immediate consequences of a costly war, and exhibiting tokens of restless insecurity, gave but little encouragement to a workman of his genius and industry to settle in the land of his birth. The compulsory drafting of men into the navy or the militia irritated the industrious classes and unsettled trade. With many of his order, Stephenson looked with a longing eye towards America, as furnishing greater scope and security to the intelligent workman and his savings. But to an untoward circumstance at this time England owes the advantage of retaining the services of one of her distinguished sons until a return to the undisturbed prosecution of peaceful pursuits gave an impetus to enterprise, and allowed the merits of the great railway engineer to be recognised and appreciated in his own country.

He had been reinstated as brakesman at Killingworth only a short time when the chances of the ballot demanded that he must serve his country as a militiaman. Fate was inexorable; he must either enter the ranks or regain his freedom by purchasing the services of a substitute. He

adopted the latter alternative. Thus was he, at a stroke, deprived of all that remained to him of his hard-won earnings, besides being compelled to borrow six pounds to make up the required smart-money. George felt this blow acutely, but the duties of his avocation, and the scientific studies that usually formed his recreation, kept him from brooding over his loss, and he earnestly set to work to retrieve his position, as well as effect economical improvements in that department of the colliery with which he was more immediately concerned. The habit which he had acquired at an earlier period, of taking his engine to pieces on Saturdays, he still followed with advantage to himself and his employers. The practical knowledge thus gained, while immediately useful in fitting him to remedy trivial defects, gave him courage to attempt important alterations which paved the way for greater successes and weightier achievements.

The sinking of the Killingworth High Pit having been commenced in the year 1810, a Newcomen engine was erected for pumping water out of the shaft. This machine proving a failure, the advice and assistance of engine-wrights in the locality, as well as of some from a distance, were sought to render it effective in performing the required service. George had studiously watched its erection, and hesitated not to express his opinion that the engine would prove defective in its action; but the brakesman's views on the subject met with very scant attention from those who heard him; and the sinking operations made but little progress on account of the water accumulating faster than it could be removed by pumping. The workmen engaged in deepening the shaft were being continually "drowned out." So confident was George in his opinion of the cause of the defect, and his power to remove it, that he said to one of the sinkers, who had asked one day what he thought of the engine:—"I could alter her, man, and make her draw. In a week's time I could

send you to the bottom." This having been reported to the viewer of the colliery, Mr. Ralph Dodds, George was speedily allowed to try his hand at that which baffled the skill of so many of much greater experience than himself. Mr. Dodds promised that he would "make a man" of Stephenson, if successful; so that the poor brakesman had now an incentive for exertion as well in the prospect thus held out as a reward of his energy, as in the desire to prove that all the self-denying industry of his early manhood had not been expended in vain.

A considerable amount of jealousy was shown by the regular engine-wrights when they discovered that the work of altering their engine had been placed in Stephenson's hands; and they did not scruple to exhibit the rancorous feelings which another's interference in their own province had evoked. But having stipulated for his personal choice of the men who were to assist him, he cared little for any ebullition of spiteful ill-will or rivalry, and threw all his energies into the perfect accomplishment of his self-imposed task. He caused the engine to be taken to pieces, and not only devised alterations in the construction, by which its better efficiency was secured, but also effected improvements in the boiler, which enabled the latter to be worked at a pressure double to that which its builders had intended should be the limit. The work of re-fitting and erecting the engine and boiler was completed in three days; and, although it was done in a rough and, what would be considered now-a-days, an unfinished manner, showed clearly that the new engine-doctor had been guided by right principles of mechanical science, both in the conception and execution of the operations.

A crowd had assembled round the engine when the hour had arrived for testing the efficacy of Stephenson's first practical essay in mechanical engineering. Some had been led thither by mere curiosity; others had gone expecting to

KILLINGWORTH HIGH PIT, WHERE STEPHENSON FIRST DISTINGUISHED HIMSELF.—*Page 47.*

triumph over the discomfiture of the precocious brakesman. The officials of the colliery, who had a personal interest in the success of the alterations, scarcely dared to hope that George would prove victorious. Newcomen, the engineer from whose plans the engine had been constructed, as well as Smeaton, who had made and erected it, had declared against the utility of the projected modifications. The engine, upon being set off, confirmed the majority of those who stood near in their opinion that Stephenson was a mere upstart and charlatan who had taken upon himself to meddle in a matter about which he knew absolutely nothing. As the unwieldy machine threatened by its erratic movements to bring down the engine-house, Mr. Dodds declared that it was really in a worse condition than before; but in an hour or two, when it had got into working trim, and the lessening of the water in the shaft had shown that it was now doing good service, even those who had come to sneer at the hardihood of attempting what appeared impossible, could not but admit that the alterations had proved successful in the extreme. Mr. Dodds was delighted at the result; and not only offered immediate tokens of his appreciation of the skill and ingenuity of his engineman, in a present of ten pounds, and advancement to the charge of the engine at the High Pit, but he also gave to Stephenson very encouraging promises of future advantage.

The success thus achieved proved the turning point in his career. The advice of the Killingworth engine-doctor was sought far and near regarding wheezy, worn-out machines and their renovation, until he came to be regarded somewhat in the light of a successful practitioner. It is true that the regular faculty of engine-curers looked upon him as a quack, who was not entitled to formal recognition at their hands; still, his invariable skilfulness increased his reputation and added to the number of his "patients." Nor were his services confined to the patching up of the

infirm. His favourable opinion of any new pumping apparatus was an assurance of its utility and value.

In the year 1812 he was appointed engine-wright of the Killingworth Pits. His predecessor having then been killed by an accident, Mr. Dodds recommended him to the notice of the owners, who leased several collieries, and who were popularly known as the Grand Allies. The recommendation being accompanied by a flattering account of his remarkable ingenuity and industry, effect was given to the representations of the head viewer, and George entered upon his greater responsibilities at a salary of two pounds a week. The confidence thus reposed by his superiors caused him to relinquish any desire for seeking his prosperity in a foreign land.

CHAPTER V.

GEORGE STEPHENSON'S FIRST LOCOMOTIVE.

HE entered upon his new duties as colliery engine-wright with a firm resolve to adhere to that course of sobriety and conscientious painstaking which had marked his service in the lower grades through which he had passed as a workman. He also determined to effect such improvements in the machinery as were calculated to make the most of his steam power, and thereby reduce the working expenditure. That his efforts were appreciated is seen in the fact that, soon after his advancement to the post of engine-wright at Killingworth, he was still further promoted by being appointed sole engineer to the various collieries leased by the Grand Allies. These included, in Northumberland, the pits at Long Benton and Killingworth, and in Durham, those at Mount Moor, Darwent Moor, and South Moor. Under his supervision the most extensive system of engine-planes then known to be in use in coal mining was successfully carried out: the coal being conveyed by sloping planes from a distance of about two miles underground, and the furthermost engine being fifteen hundred yards from the shaft. The smoke from the boilers of the engines used in working this underground traffic was

brought the latter distance by means of flues. It has also been said that he was the first to introduce tram-roads in the conveyance of coal from distant parts of the workings to the main roads in the Killingworth Pit, with small trams on which the corves or baskets containing the coal were placed. These light carriages could be conveniently pushed along the rails by boys, and the ponies and sledges previously used for that purpose were dispensed with, at a considerable saving to the owners.

Allowing no opportunity for his own improvement to pass unheeded, he increased his capability for overcoming difficulties, and strengthened his self-reliance. His thirst for knowledge still continued insatiable. Although his progress as a scholar under Andrew Robertson had been altogether satisfactory so far as it went, George resolved to prosecute his personal education still further. This he was enabled to effect through his own industry and the friendly help of a neighbouring farmer's son. John Wigham lived at Benton Glebe Farm, of which his father was the occupier. The cottage of the Wigham family being but a short distance from West Moor, Stephenson frequently took his slate to John, as he had done formerly to the Newburn schoolmaster, to have his sums checked or set down for working out in the engine-house. When the slate was not at hand, and a problem in arithmetic mentally arose before him, a piece of chalk and the side of a coal waggon answered well his purpose. The engine-wright was seldom at a loss for an expedient; while his persistency in learning, and his careful study of all the details of the question which he had for the moment in hand, met with an adequate reward in the enhanced proficiency of the eager student. His friend was useful to him in various other respects. John was not only a good arithmetician and penman, but an acute thinker, and could reason with perspicuity on matters pertaining to natural philosophy. The contact with such a

mind proved of infinite value to George in his after-career; and when he had attained the pinnacle of his fame as a railway engineer, he was not too proud to acknowledge with gratitude his indebtedness to the friendship and instruction of the Benton farmer's son.

Before he became acquainted with John Wigham, George had sometimes amused himself at his leisure moments by drawing plans of engines and tram-roads, but these were naturally of a rough and sketchy character. He now gave considerable attention to that important branch of an engineer's requirements. Wigham was a very fair draughtsman; but in learning to draw plans and sections under his eye, George proved himself such an apt pupil that he soon excelled his teacher in the art. When he had attained his thirtieth year we find him just as eager for knowledge as when, at the age of eighteen, he sat beside Robin Cowens and learnt the alphabet.

So great was his industry, that in spite of the claims of his daily duties, and the time he devoted to self-improvement, he continued his old occupation of shoemaking and mending; while he had added to this the cleaning of watches and clocks, the making of shoe-lasts for the shoemakers of the district, and the cutting out of pitmen's clothes, preparatory to the work of sewing the same by their wives. "Geordy Steevie's cut" in pit suits prevailed in the neighbourhood of Killingworth long after the ingenious "cutter" had quitted this mortal scene. By these pursuits in after hours he earned sufficient money to keep his aged parents in comfort, at a period, too, when the cost of living was exceedingly high.

But George had another incentive for adding by extra labours to the income he derived as the colliery enginewright. His son Robert was now growing a fine and intelligent lad, and having proved in his own case, by painful experience, the depressing influence of the want of

education upon a poor man's prospects in life, he earnestly determined that no self-sacrifice would be too great, could he but effect thereby the intellectual elevation of his boy. Robert had been sent to a school at Long Benton, where he was grounded in the rudiments of education; but the father knew, by having personally superintended the lad's studies at home, that the tuition imparted by the country school-master was of the most meagre description, and he resolved that Robert should receive all the benefits derivable from the instruction of one of the best masters in Newcastle-upon-Tyne. At a meeting held in celebration of the opening of the Newcastle and Darlington Railway, on the 18th of June 1844, George Stephenson alluded to this period of his life, and his self-denying efforts for his son's welfare, in the following words:—"When Robert was a little boy I saw how deficient I was in education, and I made up my mind that he should not labour under the same defect, but that I would put him to a good school and give him a liberal training. I was, however, a poor man; and how do you think I managed? I betook myself to mending my neighbours' clocks and watches at nights, after my daily labour was done, and thus I procured the means of educating my son." The paternal solicitude and forethought thus manifested were conspicuously rewarded in the brilliant career of Robert Stephenson, who, when a boy, rode daily upon a donkey from Killingworth to Newcastle, where he attended Mr. Bruce's school in Percy Street during the day; returning in the same manner in the evening to his father, who watched, as the weeks and months flew past, with glowing pride the boy's progress in learning, as well as other proofs which his son gave of increasing intellectual strength and power of observation.

The interior of Stephenson's cottage at Killingworth resembled more the shop of a dealer in curiosities than the home of a superior colliery workman. The walls were

covered with models of self-acting planes, engines, and machines of various kinds, from those of the most useful and practical character to some that could only be considered as Utopian and valueless. The latter were all that resulted from his fruitless attempts to solve the problem of perpetual motion; the former he still hoped to utilise as opportunities arose for their being embodied in future improvements. Thus surrounded, with his son by his side learning the tasks for the following day, and a favourite blackbird looking inquisitively upon the scene, George continued to mend and clean, and cobble, and study after his regular labours were over. In this way did he serve an apprenticeship which fitted him to become a mechanical engineer of eminence and fame.

Seventy years ago, the revival of the idea of applying steam locomotion to the conveyance of coal over the tramroads of the country engaged the attention of many who were pecuniarily interested in a successful solution of the question. At the beginning of the century Trevithick had constructed a high-pressure locomotive, which was considerably superior to all its predecessors; and although that engine had been abandoned on account of its defects, still enough had been accomplished by its clever but erratic inventor to pave the way for others who might have the desire and energy sufficient to bring into practical shape the crude ideas of the impatient Cornishman. Mr. William Hedley, at Wylam Colliery, where George Stephenson's early years were spent, was the first to put Trevithick's plan for a locomotive engine to a thorough test, and to prove the fallacy of such a machine requiring "friction-wheels" to further its adhesion to the rails; which notion to some extent Trevithick acted upon in common with his contemporaries. But this was accomplished by the Tyneside inventor only after experiences sufficiently adverse to have deterred one less sanguine than himself as to the utility of steam locomotion being ultimately

established. In October 1804, John Whinfield, of Pipewellgate, Gateshead, constructed for the colliery a locomotive, from plans furnished by Trevithick. That machine never left Whinfield's foundry, probably because it was too light for the work it would be required to do; and it is alleged that another engine proved likewise a failure; the story being that after it had been removed from Gateshead, when finished by Thomas Waters of that town, and tried at Wylam, it went in pieces, to the danger and alarm of the bystanders. After a series of experiments carefully conducted by Mr. Hedley, the enterprising coalowner ordered a locomotive to be built by the colliery engine-wright, Jonathan Foster, and such workmen as were available, under the direction of the ingenious mining engineer. This engine was more successful than its predecessors, but it was too heavy for the tram-road, and it was continually getting out of repair, so that horses, it is said, had usually to follow it in anticipation of its breaking down. Satisfied that Hedley was on the brink of success, Mr. Blackett ordered a fourth engine to be constructed, and it was completed at the engine-shop at Wylam, and placed upon the waggon-way, where it did good service for many years. After a career of usefulness, during which it was visited and scrutinised by the greatest mechanical engineers of the age, William Hedley's locomotive was sent to South Kensington, where it is exhibited in the Museum as the patriarch of the great Puffing-Billy family.

Soon after his appointment as engine-wright, the attention of George Stephenson was directed to the more efficient and economical transport of coal from the collieries to the shipping staiths. Having made various minor improvements in his machinery, he also succeeded in reducing the working expenses at one of the Killingworth pits by utilising the surplus power of an underground pumping-engine in drawing the coal to bank. But the laden waggons had thence to be hauled by

horses for a distance of six or seven miles, and the price of corn being at that time exceedingly high, the expenditure entailed in the transit was proportionably burdensome. To remedy this state of matters George devoted his energies, and the first practical result of his efforts to obtain a less costly motive power on the tram-road was the application of the principle of the Inclined Plane wherever that was practicable. By thus altering certain portions of the waggonway no doubt some saving was secured; but the slight pecuniary advantage thereby effected only served to whet his desire after a more tangible attainment in the direction of economy.

At various times George visited Wylam for the purpose of inquiring as to the locomotive experiments there carried on, and the prospects of success that might be entertained by his friend Jonathan Foster. When the engines were placed upon the tram-road, and while at work, he inspected them minutely: noting their excellencies and defects, and determining the points in their gearing that admitted of improvement. He also examined the Blenkinsop engine on the day of its being started at Coxlodge; and expressed an opinion adverse to its utility, which was shortly afterwards verified by the explosion of the boiler. The success attained by Hedley at Wylam, however, caused Stephenson to apply himself with ardour to the subject of locomotive construction; and he speedily brought the matter under the notice of the Killingworth owners. From the improvements in the fixed-engines which he had already been able to effect, a favourable impression regarding their engineer's ability had been formed by Sir Thomas Liddell and the other lessees; and after a statement from Stephenson as to the likelihood of the proposed "travelling engine" proved a saving, he was authorised to proceed with its construction without delay. Thus empowered, George commenced his task; and, working with such tools and assistance as he could command,

the first Killingworth locomotive was completed in about ten months, and placed upon the waggon-way.

Stephenson's first locomotive was popularly known as "Blutcher;" and altogether it was exceedingly uncouth and cumbrous in appearance, as well as unsteady in its motion. Being without springs, it jolted and jerked along in a fashion that was not calculated to give the beholder a favourable impression regarding its powers. The steam, after passing through the cylinders, escaped with a horrible noise, which caused the colliery-owners to be threatened with law proceedings, for the terror produced by the awful machine upon cattle and horses. Besides, the economical side of the question had to be studied, and this gave only a slight advantage to the engine when compared with the horse-power which it was intended to supplant. For a time, therefore, it almost seemed as if the fate of the locomotive hung in the balance; for the interest in its success was not confined to Killingworth, and a widespread feeling of repugnance to the innovation had been generated in various parts of the country. But Stephenson so altered the engine that the noise created by the emission of its steam was considerably lessened; while the means which he adopted to that end slightly increased the combustion in the furnace, and added to the effective power of the machine. These alterations in all probability saved his engine from condign destruction, and nurtured steam locomotion until it was adopted, not only upon private coal-carrying lines, but eventually by the public railways of the kingdom.

CHAPTER VI.

THE RIVAL SAFETY-LAMPS.

COLLIERY explosions, the harbingers of destruction to mining property, and bereavement to mining households, were familiar to the owners and workers at Killingworth. Shortly after Stephenson's removal to West Moor an explosion of fire-damp occasioned the loss of ten lives, while he was engaged in his duties as brakesman at the top of the shaft; and the calamity produced in him a painful impression, which was revived in the year 1809, when a similar catastrophe at the same pit deprived twelve persons of their existence. Other disasters of a like nature had also occurred at neighbouring collieries, and with even more fatal results; which circumstances exerted a powerful influence over the sympathetic nature of George, and impelled him to strive earnestly to discover a remedy for an evil which rendered the lives of the pitmen the price that was but too frequently paid for the acquisition of coal. It was not, however, until his advancement to the post of engine-wright that he was able to give practical effect to the generous resolution which he had formed.

Having personally to superintend the hauling of the coal over planes underground, he was often brought in contact

with fire-damp. Various methods had been adopted for neutralising the foul air, caused by the frequent presence of carburetted hydrogen in certain parts of the Killingworth mine. Some of the more dangerous galleries had been built up, in order to shut off the deadly gas from the other workings. Still, the sudden escape of a "blower" might occur at any moment, even in what were considered the safest places, and the flames of the lamps or candles being then unguarded, the miners were continually exposed to the chance of mutilation or a terrible death. It was to lessen this danger to miners, and reduce the mortality among them from this cause, that Stephenson set about the invention of a lamp that would at once give sufficient light to the men while at work and prevent the inflammable gas from igniting at the flame. Mr. Samuel Smiles, in his most interesting *Lives of the Engineers*, gives an anecdote which was related to him by an old Killingworth miner, and it is characteristic of the indomitable courage of the inventor of the "Geordy Safety Lamp." Mr. Smiles says:—"One day, in 1814, a workman hurried into Stephenson's cottage with the startling information that the deepest main of the colliery was on fire! He immediately hastened to the pit-head, about a hundred yards off, whither the women and children of the colliery were running, with wildness and terror depicted in every face. In a commanding voice Stephenson ordered the engineman to lower him down the shaft in the corve. There was peril, it might be death, before him, but he would go. He was soon at the bottom, and in the midst of the men, who were paralysed by the danger which threatened the lives of all in the pit. Leaping from the corve on its touching the ground, he called out, 'Are there six men among you who have courage to follow me? If so, come, and we will put the fire out!' The Killingworth pitmen had the most perfect confidence in their engine-wright, and they readily volunteered to follow

him. Silence succeeded the frantic tumult of the previous minute, and the men set to work with a will. In every mine, bricks, mortar, and tools enough are at hand, and by Stephenson's direction the materials were forthwith carried to the required spot, where, in a very short time, a wall was raised at the entrance to the main; he himself taking the most active part in the work. The atmospheric air was by this means excluded, the fire was extinguished, the people were saved from death, and the mine was preserved."

For some time previous to this incident the miners had found occasion to expostulate with Stephenson about what they considered to be his foolhardy experiments with the fire-damp. It was afterwards not an unusual thing for the men to discover him in the act of holding a light dangerously near to a fissure in the coal from which gas was escaping. As he was but a rude sort of chemist, he did not scruple to use the natural laboratory which was at hand, nor to conduct his experiments in a very unscientific fashion. His patient application to the subject, however, led him to the conclusion that by constructing a lamp with a chimney, through which a current of burnt air would be continually ascending from the flame, the inflammable gas would be prevented from igniting at the lamp, and the colliers might then pursue their labour, even in the most dangerous parts, without fear of accident. Having satisfied himself about the theory of his safety-lamp—although strictly his theory was an incorrect one—he straightway sought his friend, Mr. Nicholas Wood, the viewer of the colliery, to whom he gave a description of the invention, which he desired to see practically tested without delay. Mr. Wood executed drawings according to the inventor's explanation; and, armed with these, George made his way to Newcastle, where he ordered a lamp to be made by a tinsmith after the detailed design, and with a glass chimney which was to be furnished by a local glass firm. On the 21st of October

1815, the first "Geordy" lamp was tested in a part of the Killingworth mine that was highly explosive.

Accompanied by Nicholas Wood and John Moodie—the latter a man of great experience in coal-mining and knowledge of fire-damp—George descended the shaft with his lamp, and proceeded to one of the galleries into which the gas was coming with a hissing noise, from a fissure in the roof. In order to make the test as searching as possible, a deal partition was erected for the purpose of intercepting and collecting the gas, and rendering it more liable to ignition. That Wood and Moodie considered the danger was great to which George exposed himself in venturing into such a neighbourhood with an untried lamp, was shown by both retiring to a place of safety while the inventor tried the efficacy of his apparatus alone. Confident in its power to protect the property of his employers as well as the lives of his friends and himself, he boldly advanced within the dangerous precincts, and held his lighted lamp within a few inches of the fissure, and in the full current of the inflammable gas. The flame was extinguished by the deadly "blower," but without exploding the foul air which surrounded the lamp. Stephenson, although neither a philosopher nor a chemist, had gained a scientific victory. Repeated experiments by the inventor, and those who attended him, demonstrated the security of the flame under the most unfavourable circumstances; but further improvement in the construction of the lamp being desirable in order to increase its illuminating power, George, with his usual energy, applied himself to the full accomplishment of his purpose.

In all his researches into the qualities and effects of fire-damp, he had been unassisted by reference to the opinions of others on the subject. It should also be borne in mind that at the time he was prosecuting these investigations, the claims of the locomotive, then upon its trial, absorbed much

of the attention and leisure at his disposal, after fulfilling his duties at the various collieries of which he was the engineer. The success of his invention so far had not been due either to the scientific accuracy of the theory upon which it had been planned, or the experiments of others in the same direction. The end in view, namely the production of a safe light-giving agent in the dark recesses of a collier's daily workshop, had been practically attained by the untiring industry and courage of the inventor. In seeking to improve his lamp, Stephenson's self-reliance had to be again called mainly into requisition, although the confidence of his friend, Nicholas Wood, had now been secured, and that gentleman rendered what assistance he could in the further experiments that were made.

When giving his evidence before the Committee on Mining Accidents, in the year 1835, George Stephenson thus referred to the tests which he instituted in order to perfect the efficiency of his lamp. He said:—"I made several experiments as to the velocity required in tubes of different diameters, to prevent explosion from fire-damp. We made the mixtures in all proportions of light carburetted hydrogen with atmospheric air in the receiver, and we found by the experiments that when a current of the most explosive mixture that we could make was forced up a tube four-tenths of an inch in diameter, the necessary current was nine inches in a second to prevent its coming down that tube. These experiments were repeated several times. We had two or three 'blows up' in making the experiments, by the flame getting down into the receiver, though we had a piece of very fine wire-gauze put at the bottom of the pipe, between the receiver and the pipe through which we were forcing the current. In one of these experiments I was watching the flame in the tube, my son was taking the vibrations of the pendulum of the clock, and Mr. Wood was attending to give me the column of

water as I called for it, to keep the current up to a certain point. As I saw the flame descending in the tube I called for more water, and Wood unfortunately turned the cock the wrong way; the current ceased, the flame went down the tube, and all our implements were blown to pieces, which at the time we were not very able to replace." It was after repeated tests had been conducted, under similarly discouraging circumstances, that the "Geordy" lamp attained its great efficiency, and the high estimation in which it has been held by those for whose personal safety it was devised by the Killingworth engineer.

While the humble overseer of colliery machinery was thus endeavouring to improve his invention, one of the greatest philosophers of the age was employing his vast knowledge, experience, and resources in designing a similar contrivance. At the invitation of an influential committee which had been formed for the purpose of devising the best means of preventing fire-damp explosions, Sir Humphrey Davy had determined to solve the problem if possible, and in connection with his investigations, the distinguished chemist visited some of the Tyneside collieries on the 24th of August 1815. Of that visit and its purport Stephenson had no information at the time; and it was not until the 9th of November following that Sir Humphrey Davy read his dissertation, "On the Fire-Damp of Coal Mines, and on Methods of Lighting the Mine so as to Prevent its Explosion," before the Royal Society of London. In the course of his experiments Davy had made the important discovery that fire-damp explosion could not pass through tubes of a certain diameter, and on that theory he invented his lamp and described it to the members of the Royal Society. But George Stephenson had proved by a practical test in one of the most dangerous galleries of the Killingworth pit, and at the hazard of his life, the same scientific fact, although in his experiment he had endeavoured to find the source of

safety from explosion in another cause. Thus the two inventors were distinct but similar, and it was only when the question of priority was raised that we find any attempt to detract from the merits of either.

The first "Geordy" lamp was proved as to its safety, as we have seen, on the 21st of October 1815. Fourteen days after—on the 4th of November—Stephenson's second lamp was similarly tested, and found to be not only as safe as the first, but also of greater illuminating power. On the 9th of November the first "Davy" lamp was shown in London. In point of priority, therefore, history must give the place of honour to the "Geordy," and acquit its ingenious contriver from any charge of attempting to appropriate to himself a merit to which he was not honestly entitled; especially when we are assured that neither on the 20th of November, when Stephenson went to order his third lamp from a Newcastle plumber, nor ten days afterwards, when the new lamp was experimented with in the pit at Killingworth, had either the inventor or his friend Mr. Wood heard of the "Davy" lamp, or of the experiments which had led to its construction.

Having been urged to bring his invention under the notice of the Literary and Philosophical Society of Newcastle-upon-Tyne, Stephenson consented, but with considerable reluctance, and upon the understanding that Nicholas Wood was to act in the capacity of spokesman upon the occasion. Upwards of eighty gentlemen having met on the 5th of December 1815, for the purpose of seeing the lamp and hearing it described, Mr. Wood proceeded to carry out the duty he had undertaken. He had not, however, a sufficient knowledge of the apparatus to enable him to answer correctly some of the questions that were put by members of the Society; and consequently George was compelled to throw off his natural diffidence and reserve, and take the matter of expounding the principle and construction of his lamp into

his own hands. Having concluded his description, even to minute details, he then endeavoured to give ocular demonstration of the success which he had achieved, by various and repeated experiments with carburetted hydrogen gas, which had been collected into bladders in the mine for that purpose. His broad Northumbrian dialect, his earnestness and confidence in his invention, as well as the unassuming manner of his address, arrested attention and made a favourable impression upon his auditory; while the practical proofs which he gave of the *safety* of his invention created an animated interest among many of the gentlemen who witnessed the experiments.

The rival safety-lamps thus having been placed before the public, considerable controversy arose as to their respective merits; while some of the gentlemen who had seen the "Geordy" exhibited before the Newcastle Society declared the "Davy," upon its first appearance in the North, to be the same as Stephenson's. Sir Humphrey's friends, with more zeal than discretion, sneered at the mean condition of the Killingworth engineer, and derided his lack of chemical knowledge and consequent ability to devise such an important invention. Experience has proved, however, that much needless anger and vituperation were imported into the discussion. After the lapse of sixty-five years, we find both lamps doing effective service in lessening the danger of explosion to the miner, and both also bearing out the opinion of disinterested critics regarding them, given when the controversy was at its height.

In the year 1816 steps were taken to raise a subscription for the purpose of presenting a suitable testimonial to *the inventor of the safety-lamp.* Finding that Stephenson's claim to priority in the invention was likely to be ignored, and his labours unrewarded, his friends determined upon making an effort to secure for him that consideration to which he was entitled. It is pleasing to note that through-

out the further proceedings no attempt was made, either by George or those who acted on his behalf, to detract from the honour which was due to Sir Humphrey as *an inventor of a safety-lamp.* All that was asked for, in Stephenson's interests, was the admission that his invention had been produced *before* Davy's, and that the two designs should be judged relatively by results. After a number of meetings, and much discussion on the subject, the sum of two thousand pounds was presented to Sir Humphrey Davy as *the inventor*, while a purse of one hundred guineas was voted to George Stephenson for what he had accomplished towards the same end. The result was satisfactory neither to the Killingworth engineer nor to those who had espoused his cause; so, to put the matter fairly before the public, Stephenson was advised to publish a statement in which his claims should be justified by the forceful logic of facts.

With the assistance of his son, George prepared a written summary of the work in connection with his invention. That paper was the first he had been called upon to indite with a view to publication. As might be expected, the author approached his task with much misgiving; and it was only finished after several evenings had been occupied in the composition. Having been completed, corrected again and again, and copied by Robert in his best hand, the carefully-prepared document was submitted to Mr. Brandling of Gosforth, the gentleman who had suggested the desirability of its publication, who revised it so as to make it more presentable in type; and it appeared shortly afterwards in the local newspapers. The publication of Stephenson's narrative, backed as it was by the earnest advocacy of many friends who were satisfied that he had established the validity of his claim, had the effect of arousing public sympathy in his favour, and resulted in the subscription of one thousand pounds as a reward "for the valuable service he had thus rendered to mankind." At a public dinner in

the Newcastle Assembly Rooms, George was presented with a silver tankard and the balance of the handsome sum which had been collected. The following inscription was engraved upon the tankard:—"This piece of plate, purchased with a part of the sum of £1000, a subscription raised for the remuneration of Mr. George Stephenson for having discovered the fact that inflamed fire-damp will not pass through tubes and apertures of small dimensions, and having been *the first* to apply that principle in the construction of a safety-lamp calculated for the preservation of human life in situations formerly of the greatest danger, was presented to him at a general meeting of the subscribers, Charles John Brandling, Esq., in the chair, 12th January 1818."

Although justice had been thus tardily extended to the Killingworth inventor, it remained for time, and the test of a prolonged use of the "Geordy" lamp, to establish for it a superiority greater by far than anything involved in the mere fact of its priority of production. Nor in expressing an opinion favourable to Stephenson rather than to Sir Humphrey, when the merits of their respective inventions come to be weighed in regard to the maximum of *safety* afforded by each, must we be considered as seeking to undervalue Davy's invention in order thereby to place an additional laurel in Stephenson's wreath. The circumstance under which the great philosopher undertook his task, and the generous relinquishment of any pecuniary interest in it after it had been completed, redound to the honour of his memory. He had been invited, by those who had great interests at stake in mining operations, to devise a safeguard against the destruction of property as well as the sacrifice of life; and his invention, as a saviour of capital, had a monetary value as well as a life-saving excellence. But, for the sake of humanity, he repudiated for himself all personal advantage, and thereby enhanced, if that were possible, the worth of his invention.

Lord Brougham, in his *Lives of Philosophers*, thus alludes to the safety-lamp which had been given to the country by his friend Sir Humphrey Davy:—

"The dreadful ravages made on human life by fire-damp explosions—that is, the burning of hydrogen gas in mines—had often attracted the notice of both the mine-owner and the philanthropist. Various inventions had been fallen upon to give light in those recesses of the earth, with so low a degree of heat as should be insufficient to explode the gas. One of them was a series of flints playing by machinery against each other, so as to give a dim light; but this had very little success: it was clumsy, and it was not effectual so as to cause its use by miners. The ventilation of the galleries by furnaces, and even by air-pumps, was chiefly relied on as a preventive; but the gas would still collect in spite of all preventives, and the destruction of a hundred or more lives was not an unusual calamity. Davy, about the year 1815, turned his attention to the subject, and after fully ascertaining that carburetted hydrogen is the cause of the fire-damp, and finding in what proportions it must be mixed with air in order to explode (between six and fourteen times its bulk), he was surprised to observe, in the course of his experiments made for the purpose of ascertaining how the inflammation takes place, that the flames will not pass through tubes of a certain length or smallness of bore. He then found that if the length be diminished, and the bore also reduced, the flames will not pass; and he further found that by multiplying the number of the tubes, their length may safely be diminished to hardly anything, provided their bore be proportionably lessened. Hence it appeared that gauze of wire, whose meshes were only one-twenty-second of an inch diameter, stopped the flame and prevented the explosion. The candle or lamp being wrapped in such gauze, and all access to the external air prevented except through the meshes, it is found that the lamp may be safely introduced into a gallery filled with fire-damp; a feeble blue flame will take place inside the gauze, but no explosion, even if the wire be heated nearly red. The theory is, but it seems very questionable, that the conducting power of the wire carrying off the heat prevents a sufficient quantity reaching the explosive compound. Subsequent inquiries seem to prove that although in a still atmosphere of explosive gas the lamp is a perfect protection, yet it does not prevent a current of gas from penetrating to the flame and exploding. It is attempted to guard against this by interposing a tin shield or screen; but a current very often in mining operations arises before any notice can be given. Had Davy's life and health been prolonged, he might have further im-

proved his invention so as to meet this objection. He certainly never was fully convinced of its force, as I know from having discussed the subject with him; and no doubt the testimony of so great an engineer as the late Mr. Buddle, given before a Parliamentary Committee to whom the examination of this important subject was referred, deserves great attention. He positively affirmed that 'having seen 1000, and sometimes 1500 safety-lamps in daily use, and in all possible varieties of explosive mixtures, he had never known one solitary instance of an explosion.' As for the lamentable accidents which continue to happen, we can scarcely doubt that they originate in the dreadful carelessness of their own and of other men's lives, which seems to be engendered in those who are habitually exposed to great danger. That they themselves are the first to suffer for it, can only suppress the outward expression of the feelings which recklessness like this is fitted to produce."

When the heat of discussion had subsided, and experience enabled practical men to judge of the two inventions without undue prejudice in favour of either, the "Geordy" lamp was found to be superior to the "Davy," in that it afforded greater security to the miner while at work in highly explosive situations. The correctness of that opinion has frequently been demonstrated; as it is found that whenever the inflammability of the atmosphere in galleries is so intense as to render red-hot the wire-gauze of Sir Humphrey's lamp, the flame of a "Geordy" is at once extinguished—a fact that renders the latter peculiarly adapted for use in deep workings and other dangerous places.

Before leaving the subject of the rival safety-lamps, it may interest some readers to learn that now—in the year of the Stephenson centenary—the great value and excellence of the Killingworth engineer's invention have received further confirmation, after various experiments. Mr. Robert Reed, viewer of Felling Colliery, near Newcastle, and of long practical experience in mining, has for some time given his attention to the question of the safest and most efficient lighting of the mine under his charge: one, it may be noted,

which upon at least two occasions prior to the invention of a safety-lamp gave deadly evidence of its explosive nature. In the year 1812, from an explosion of fire-damp in the pit, ninety men and boys were either burnt to death or suffocated; while in the following year twenty-two persons lost their lives from a similar cause. With such a record of disaster in the history of his mine, Mr. Reed was desirous of having the safest illuminating agent possible in his workings; and many investigations and various trials have proved beyond a doubt the decided superiority of George Stephenson's safety-lamp, not only over its old rival the "Davy," but also more modern contrivances. Orders have therefore been lately given for the manufacture of safety-lamps for Felling Colliery after the pattern of the "Original Geordy."

CHAPTER VII.

THE FIRST PUBLIC RAILWAY.

SATISFIED with the alterations which he had effected in his first travelling engine, but anxious to place the question of the utility of steam locomotion in the transport of coal beyond the region of uncertainty, Stephenson engaged in further inquiry and trials. To the prosecution of these he devoted much patient thought and unflagging industry. He was sensibly aware that his engine had many defects; not the least of which was its somewhat complicated gearing. Directing his efforts, therefore, to the construction of another which should possess in its form and cost the desiderata of simplicity and economy, he so far succeeded as to be able to take out a patent, in February 1815, for a locomotive which combined these essentials in a remarkable degree. It contained the germ of much that has been subsequently produced, and may be considered as the type upon which has been moulded the locomotive of the present day.

But Stephenson did not confine his attention alone to the improvement of the motive-power which he desired to see adopted. In his experiments he had arrived at the settled conviction that a superior form of travelling engine demanded a better road upon which to run than any that

had been hitherto laid down. In the laying of rails little care had been taken to remove inequalities in the roadway. The levelling had been very imperfect at the outset, and the lack of systematic repairs allowed the rails to become so depressed at intervals as to cause not only great loss of power in the engine, but considerable detriment also to the machinery, through the continued jolting which it sustained in the course of the journeys. To alter this state of matters he applied himself with energy, and the result of his thought and labour appeared in an improved rail and chair for the road, and in malleable iron wheels and a steam substitute for springs in the locomotive. These various improvements were specified in a patent granted in September 1816, jointly to William Losh, ironfounder, of the Walker Iron Works, Newcastle, and George Stephenson—Mr. Losh furnishing the capital.

With an improved locomotive and railway, Stephenson was now enabled to conduct the coal traffic from his colliery with increased regularity, while the advantage of greater economy in working was found to be on the side of the engine when compared with the horse-haulage. He had therefore arrived at a point in his labours from which he might prosecute further researches into the region of possibility without being harassed as formerly with the thought that his efforts were unproductive of practical benefit to his employers. In October 1818, with Mr. Nicholas Wood, he instituted experiments with a dynamometer, constructed by himself, for the purpose of determining with accuracy the resistance offered to carriages while travelling on the railway. These observations were the first of their kind, and confirmed the deductions of Vince and others as to the theory that friction is a constant quantity at all velocities—a theory that was then scouted by many engineers. Thus was he being gradually trained and fitted for the great work that lay before him as the pioneer of the railway system.

Five years had elapsed from the completion of the first Killingworth locomotive before any attempt was made to extend the principle to the working of the coal traffic in other places. Stephenson himself had great confidence in his hypothesis that the union of the travelling engine and the railway was destined to effect stupendous results; but his locomotives continued to do their accustomed work without exciting more than a passing interest in casual observers of their immense power and ungainly appearance. The general public took no interest in an uninviting subject such as the conveyance of coal, and if other coalowners did really from time to time scrutinize the improved motive-power on the Killingworth Railway, they took care to keep the result of their inspection to themselves. So disheartened did George become at length with the apathy of his countrymen regarding the subject which mainly engrossed his thoughts, that he once more reverted to his old idea of crossing the Atlantic and pushing his fortune under less depressing and discouraging conditions.

In the year 1819, Stephenson began to reap the first-fruits of his patience, energy, and toil. His locomotives having effected a decrease in the cost as well as an increase in the speed of the traffic over the Killingworth line, an important Durham Company decided upon altering their waggon-way so as to allow the adoption of locomotive power in the transit of coal from Hetton Pit to the River Wear at Sunderland. Stephenson was asked to devise and superintend the alterations, and the manner in which he brought these to a successful termination, as well as the careful economy which guided him in his work, showed that while he was competent to deal with engineering questions in a firm and accurate manner, he was too wise to risk the prosperity of the undertaking in order that he might achieve a showy but questionable result. The length of the Hetton line was about eight miles, crossing in its course the hill

called Warden Law. In forming it, Stephenson endeavoured as much as possible to adapt the working of the railway to the natural condition of the ground over which it passed. Consequently, he utilised five of the heavy gradients as self-acting inclines, and the remaining two were worked by fixed engines. Other portions of the line being suitable for locomotive power, travelling engines conveyed the waggons to and from each incline. On the 18th November 1822 the new Hetton Railway was opened for traffic; five locomotives constructed under Stephenson's direction being upon the line under the charge of his brother Robert. With a train of seventeen waggons, weighing about sixty-four tons, each engine travelled at a speed of about four miles an hour. A large number of spectators assembled to witness the inauguration of George's first important work in railway engineering, the complete success of which gratified the proprietors of the line, and gave increased confidence to the engineer to engage in a larger and more important undertaking.

Edward Pease, the projector of the first public railway, had many difficulties to surmount ere the formation of the Stockton and Darlington Railway Company became an accomplished fact. Although the scheme was one of public utility rather than of private advantage, those who were most likely to be benefited by its completion either withheld support or offered opposition. Among the inhabitants of South Durham generally the proposed line was declared to be a preposterous idea, which, if carried out, could only end in disaster to its unfortunate shareholders. But Mr. Pease held firmly to his purpose, and by the aid of relatives and personal friends the required capital was subscribed. It is said that the shares allotted in the town of Stockton did not amount to twenty.

In the year 1818, the first application was made to Parliament for an Act authorising the construction of the

contemplated line, but the Bill was successfully opposed by the Duke of Cleveland. Another survey having been made by which the fox-covers of his Grace were not invaded, the promoters were more fortunate in their second application for Parliamentary powers, and the first Stockton and Darlington Railway Act received the Royal Assent on the 19th April 1821. By the Act, authority was given "for making and maintaining a railway or tramroad from the river Tees, at Stockton, to Witton Park Colliery, with several branches therefrom, all in the county of Durham;" but no power had been asked for working the proposed railway by locomotives, and it was not until the year 1823 that the omission was rectified by a clause in a supplementary Act passed on the 23rd of May. In that second statute, the company was empowered to "make, erect, and set-up one permanent or fixed steam-engine, or other proper machine, in such convenient situation as might be selected; also to use locomotives or movable engines for the purpose of facilitating the transport, conveyance, and carriage of goods, merchandise, and other articles and things, upon and along the same roads, and for the conveyance of passengers upon and along the same roads." The use of locomotives on the first public railway was urgently recommended by the engineer, George Stephenson, and the necessary power to employ such haulage was obtained on his advice.

The construction of the Hetton Railway, there can be little doubt, was the means of bringing the capabilities of the engineer before the Darlington projector in a prominent manner. The first interview between Edward Pease and George Stephenson took place ten days after the passing of the Stockton and Darlington Act of 1821, and was referred to by Mr. Nicholas Wood, who was also present upon the occasion, in an address given by him many years after. Mr. Wood said:—"The fact is, we rode on horseback from Killingworth to Newcastle, a distance of five miles, travelled

from thence by coach, thirty-two miles, to Stockton, then walked along the proposed line of railway, twelve miles, from Stockton to Darlington. We had then the interview with Mr. Pease, by appointment, and afterwards walked eighteen long miles to Durham, within three miles of which I broke down . . . . but was obliged to proceed, the beds being all engaged at the 'Travellers' Rest.' This interview with Mr. Pease, which was on the 19th of April 1821, had the effect of Stephenson being ultimately appointed engineer to the Stockton and Darlington Railway."

At various times prior to 1818, ineffectual attempts had been made to develop the mineral resources of South Durham by means of a canal; and in that year the scheme was revived, in opposition to the railway project of Edward Pease. On economical grounds the railway was found to offer greater advantages, and that gentleman therefore gave all the weight of his great influence and advocacy in favour of the iron and against the water highway. The latter proposal being abandoned by its supporters, Mr. Pease and his friends were left to carry out the construction of the railway, while their opponents looked on their efforts with chilling apathy or heated disapproval.

The first survey of the projected line was conducted by Mr. George Overton, an engineer and contractor of South Wales, who felt considerably irritated at the rejection of the Bill of 1818, and at the fact of his recommendations having been set aside by Mr. Pease and the committee appointed to carry the scheme to completion. But the projectors foresaw the difficulties and expense that would be encountered if they persisted in prosecuting a route which brought them into antagonism with such a powerful landowner as the Duke of Cleveland, and they wisely determined to have a second survey taken with a deviation from the line of the first, which they considered was calculated to allay the irascibility of the noble fox-preserver. Mr. Overton accor-

dingly made another survey, and by dint of most strenuous exertions, for the purpose of enlisting the support of members of Parliament and removing the objections of peers of the realm in regard to the project, the second Bill was carried, as we have stated, and the committee proceeded to the practical portion of their labours.

Immediately after the visit to Mr. Pease of Stephenson and his friend Nicholas Wood, the directors of the railway took into consideration the appointment of an engineer for the line. Satisfied of the sterling character of the north-country candidate for the appointment, the directors empowered Edward Pease to write to George asking him for information as to his terms for re-surveying the route as laid out by George Overton, with a view to ascertaining whether the construction of such a line would be practicable; and, generally, to determine the possibility of effecting greater economy and utility in the construction and working of the railway than would be attained by a strict adherence to Overton's survey. The letter written to Stephenson by Mr. Pease was a model communication, exhibiting careful forethought and business capacity in the writer, and a true estimate of the capability and trustiness of him to whom it was addressed. The reply of the engineer was as follows:—

"EDWARD PEASE, ESQ.

"SIR,—After carefully examining your favour, I find it impossible to form an accurate idea of what such a survey would cost, as not only the old line must be gone over, but all the other deviating parts, which will be equal to a double survey, and, indeed, it must be done in a very different manner from your former one, so as to enable me to make a correct measurement of all the *cuts and batteries* on the whole line. It would, I think, occupy me at least five weeks. My charge shall include all necessary assistance for the accomplishment of the survey, estimates of the expense of cuts and batteries on the different projected lines, together with all remarks, reports, &c., of the same. Also the comparative cost of malleable iron and cast iron rails, winning and preparing the blocks of stone, and all materials wanted to complete the line. I

could not do this for less than £140, allowing me to be moderately paid. I assure you, in completing the undertaking, I will act with that economy which would influence me if the whole of this work was my own.

"GEORGE STEPHENSON.

"KILLINGWORTH COLLIERY, *August 2nd*, 1821."

Arrangements having been concluded, Stephenson began his survey in the autumn of 1821, and the work was completed with so much satisfaction and credit to the directors and himself, that he was appointed engineer to the company, at a salary of £660 per annum, inclusive of the cost of assistance and personal expenses. In the labour of laying out the railway he was aided by his son Robert, and a young man named John Dixon who eventually attained the position of consulting engineer to the directors. As chairman of the company, Mr. Thomas Meynell of Yarm laid the first rail, and the ceremony was made the occasion of public rejoicing. This preliminary observance took place on the 23rd May 1822, in the vicinity of St. John's Well, Stockton.

The formation of the line having been fairly started, Stephenson next proceeded, but with cautious circumspection, to advocate the use of locomotives where practicable; one portion of the railway going over a hilly tract of country which involved the construction of a heavy incline, for the working of which travelling engines would have been unsuitable. In making his first estimate he refrained from setting down any sum for locomotive charges, seeing that up to that time the directors had contemplated the employment of horse-power only for the more even parts of the road. He now began to see, however, that the adoption of locomotive haulage depended upon his being able to satisfy the directors that such a motive power was not only more economical, but at the same time that it would conduce to greater regularity in the working of the line. For the purpose of having the question decided, Stephenson

waited upon Mr. Edward Pease, whom he invited to Killingworth, in order that the locomotives might be there seen at work, and that Mr. Pease might inform himself as to the cost of such haulage from the colliery accounts. Benjamin Thompson, of Eighton Banks, having procured a patent for a fixed engine, and urged its employment on the Stockton and Darlington line, Mr. Pease was naturally uncertain as to which description of engine should be secured. However, having great confidence in the value of his own engineer's opinion, and for the purpose of testing the powers of the Killingworth engines, he agreed to visit the Northumberland Colliery before definitely advising his brother directors in the matter.

On the day of his arrival at Killingworth, Mr. Pease found that George was engaged in one of his acts of duty down the pit, but being called therefrom, the engineer was quickly employed in giving his visitor a practical illustration of the wonderful capabilities of the locomotive. Thenceforward the railway projector associated the question of the perfect success of his scheme with the union of the travelling engine and the rail. The result of the visit to Killingworth led the directors to decide that locomotives should be employed on the Stockton and Darlington Railway.

The upright character of George Stephenson was exhibited when the question arose as to the kind of rails which should be laid upon the road. As already stated, he was interested jointly with Mr. Losh, of Walker, in a rail which had been patented; and its adoption would have conferred upon himself considerable pecuniary benefit. He preferred, however, to act conscientiously in the matter, and when asked for his opinion, strongly advised the use of malleable rails in preference to cast-iron ones, in the manufacture and sale of which he had a personal interest. The directors gave orders for the laying of the former, as an experiment, only on a portion of the line.

Before the projection of the Stockton and Darlington Railway, considerable difficulty had been experienced in the building of locomotives, on account of the want of skilled mechanics for the work. The whole of Stephenson's engines for the Killingworth and Hetton lines had been made by colliery operatives, and it was felt that before much improvement could be effected in the form or action of the locomotive, workmen would be required who were specially qualified for such labour by having undergone a training in engine-fitting. Throughout his experiments in connection with the construction and alteration of his engines, George had been harassed, and his efforts had been retarded, by reason of the men who were employed to assist him being frequently unable to carry out his instructions; and for the purpose of remedying this hindrance, as well as engaging in a profitable speculation, he determined to commence business as a manufacturer of locomotives. He had intact the amount of his testimonial for the invention of a safety-lamp; and with that sum, and £1000 put into the concern by Edward Pease and his cousin Thomas Richardson—the latter a gentleman whose influence had been of great value in projecting the Stockton and Darlington Railway—the well-known engine works in Forth Street, Newcastle, were founded, under the firm of Robert Stephenson & Company.

On the 16th September 1824, the first order for locomotives was given to the new firm by the directors of the line; and in obedience to that order, two engines were built at a charge of £500 each. The first to be employed on a public railway was named "Locomotion," and it headed the inaugural procession on the opening day. After serving well its generation, it now stands upon a pedestal at the Darlington Station, in North Road, where it was placed in June 1857. Besides furnishing locomotives for the line, R. Stephenson & Co. erected at the Brusselton hill-top

two thirty horse-power stationary engines, with combined axle, for drawing trains up the incline. Two engines of similar construction, but of half that nominal power, were erected at Etherley hill-top also by the same firm. The cost of these four engines was £5465, 10s.; the size of the working cylinders being thirty inches for the two at Brusselton, and those at Etherley having cylinders of twenty-two inches.

"The conveyance of passengers," Mr. Wood remarks, "did not form a part of the original intentions of the promoters. The conveyance of coals at the cheapest possible rate was the desideratum, and the principle which Stephenson was instructed to proceed upon. High rate of speed was no element for the consideration of either directors or engineers. Heavy loads, conveyed at moderate rates of speed, were alone considered. Hence the locomotive engines to be used on the Stockton and Darlington Railway were constructed to travel from four to six miles an hour, with the heaviest load which the power of the boiler in raising steam enabled them to accomplish; and hence also we find, on Messrs. Walker and Rastrick's visit in 1829, ... they place the performance of the engines at $47\frac{3}{4}$ tons of goods, $23\frac{1}{3}$ tons weight of carriages, the engine and the tender weighing 15 tons—making altogether a gross weight of $86\frac{1}{2}$ tons, moved at five miles an hour." The purpose of the promoters was to encourage the use of the railroad, on certain conditions, by the owners of waggons and coaches plying between the terminal towns. In 1833 the company became the sole carriers of goods and passengers.

The main line having been completed, the directors immediately made arrangements for working the traffic; while they also took steps to celebrate the opening of the railway in a manner worthy of the auspicious occasion. In announcing the preliminary ceremony, the following handbill was issued:—

THE

STOCKTON & DARLINGTON

RAILWAY COMPANY

Hereby Give Notice,

THAT the FORMAL OPENING of their RAILWAY will take place on the 27th instant, as announced in the public Papers.—The Proprietors will assemble at the Permanent Steam-Engine, situated below BRUSSELTON TOWER,* *about nine miles west of* DARLINGTON, *at eight o'clock, and, after examining their extensive inclined Planes there, will start from the Foot of the* BRUSSELTON *descending Plane, at nine o'clock, in the following Order:—*

1. THE COMPANY'S LOCOMOTIVE ENGINE.
2. The ENGINE'S TENDER, with Water and Coals.
3. SIX WAGGONS, laden with Coals, Merchandise, &c.
4. The COMMITTEE, and other PROPRIETORS, in the COACH belonging to the COMPANY.
5. SIX WAGGONS, with Seats reserved for STRANGERS.
6. FOURTEEN WAGGONS, for the Conveyance of Workmen and others.

☞ *The WHOLE of the above to proceed to STOCKTON.*

7. SIX WAGGONS, laden with Coals, to leave the Procession at the DARLINGTON BRANCH.
8. SIX WAGGONS, drawn by Horses, for Workmen and others.
9. Ditto. Ditto.
10. Ditto. Ditto.
11. Ditto. Ditto.

The COMPANY'S WORKMEN to leave the Procession at DARLINGTON, and DINE at that Place at ONE o'clock; excepting those to whom Tickets are specially given for YARM, and for whom Conveyances will be provided, on their arrival at STOCKTON.

TICKETS will be given to the Workmen who are to dine at DARLINGTON, specifying the Houses of Entertainment.

The PROPRIETORS, and such of the NOBILITY and GENTRY as may honour them with their company, will DINE precisely at THREE o'clock, at the TOWN HALL, STOCKTON.—Such of the party as may incline to return to DARLINGTON that Evening, will find Conveyances in waiting for their Accommodation, to start from the COMPANY'S WHARF there precisely at SEVEN o'clock.

The COMPANY take this Opportunity of enjoining on all their WORKPEOPLE that attention to *Sobriety* and *Decorum*, which they have hitherto had the Pleasure of observing.

The COMMITTEE give this PUBLIC NOTICE, that all Persons who shall ride upon, or by the sides of, the RAILWAY, on Horseback, will incur the Penalties imposed by the Acts of Parliament passed relative to this RAILWAY.

RAILWAY OFFICE, *Sept. 19th, 1825.*

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* Any Individuals desirous of seeing the Train of Waggons descending the inclined Plane from ETHERLEY, and in Progress to BRUSSELTON, may have an Opportunity of so doing, by being on the RAILWAY at ST HELEN'S AUCKLAND not later than Half-past Seven o'clock.

The opening of the first public railway was effected with every expression of satisfaction and rejoicing on the part of the promoters and the public in general. The prophets of evil regarding it were obliged to conceal disappointment at the success of the scheme, and wait for other opportunities of exhibiting their rancorous feelings. On the 27th of September, 1825, the committee met, in terms of the programme, at the bottom of Brusselton incline, after inspecting the Etherley fixed engine. The train, loaded with coals and goods, was then drawn up the eastern ridge, a distance of one thousand nine hundred and sixty yards, by the Brusselton engine, in seven and a half minutes; when it was lowered on the incline at the east side of the hill, a further distance of eight hundred and eighty yards, in five minutes. At the foot of the plane, "Locomotion" stood ready to be attached to the carriages, amid the wonderment, fear, and admiration of the assembled spectators. As well to give effect to the procession as for the purpose of guarding against accident, men were employed to ride in front of the engine and herald its approach, by the exercise of their voices and the waving of flags.

The first public railway train consisted of thirty-eight carriages, and its engine was driven by George Stephenson, who was both the designer and builder. It had been intended to limit the number of passengers to three hundred, but the great pressure of the crowd upset the arrangements in that particular, and by the time the train reached Stockton, not less than six hundred persons occupied seats or hung on the vehicles in one position or another. The distance of twelve miles, with the various stoppages upon the road, was accomplished in three hours and seven minutes. All along the route sightseers were crowded on every bit of vantage ground, and when the procession neared Stockton it was followed by a large number of persons on foot, in vehicles, and on horseback. It has been said that "the passengers

by the engine had the pleasure of observing the difference between the engine, with her six hundred passengers and load (of eighty tons), and the coach, with four horses and only sixteen passengers." At the close of the day the good performance of "Locomotion" formed the subject of general conversation as well as after-dinner speeches.

The Stockton and Darlington Railway having been constructed for the purpose of developing the coal trade of South Durham, and bringing the supply from the pits of the district into the export market, it was satisfactory to the directors that one of the first contracts made by them for the transport of coal along the line was that for the carriage of one hundred thousand tons annually for five years by one London firm alone. That traffic of itself insured to the shareholders a dividend of four per cent. on the cost of construction, while another immediate effect of the opening of the railway was the reduction of the former price of coal to the extent of one-third in favour of the general public of the neighbourhood.

In the month of October, 1825, the first railway passenger coach commenced running; horse-power being employed, and the directors advancing the sum of £25 to one Thomas Close, upon his giving security for the purchase of a horse and harness for the purpose. The directors do not appear to have attached much importance at first to the passenger traffic as a source of revenue; and this branch of conveyance drifted into the hands of private proprietors, who worked it on terms of lease. The first coach was built at Newcastle, by Stephenson, after his own design, and at the cost of the company. It resembled a showman's caravan, and it formed part of the procession at the opening of the line. The seats were placed along the sides of the interior, and a deal table stood in the centre of the vehicle, which had been named "Experiment" by its designer. It was the only passenger carriage of the company in the year

1825. In Longstaff's *History of Darlington*, the sensations attendant upon an early railway journey between Stockton and Darlington are thus described:—"The coach had no springs of any kind, and yet the motion was fully as easy as in any coach on the road. A very slight jolt is felt, accompanied with a click or rattle, every time the wheels pass over the joints of the several rails, and also at the breaks which occur at the different passing places, and then, if anything, feels harsher than in a coach. At any bends of the road, or other places where the view is obstructed, the coachman blows a horn to give warning of his approach to any waggons or vehicles that may be coming or going on the way. Some parts of the way were laid with rails of cast-iron, joined at every four feet, and in coming upon these the jerks and jolts were more frequent, more audible, and more sensible, resembling exactly . . . the clinking of a mill hopper."

The first lessee for the conveyance of passengers was a Darlington contractor, named Pickersgill, and the success of his venture soon led others to apply to the directors for "running powers," until, in the years 1831–32, we find seven different coaches, belonging to various proprietors, performing journeys at stated times, regulated by special orders from the company. Little outlay was involved in the construction of these early passenger carriages. A rough underframe, on four flanged wheels, and supporting the body of an old, worn-out stage-coach, was all that was thought necessary for the comfort of travellers. The difference between the inside and outside fares raised a distinction which has been perpetuated in first, second, and third class compartments. The mail-coach speed being ten miles an hour, the railroad vehicles were gradually obliged to quicken their rate of progression until that was equal to the rapidity of travelling by the mail. The subjoined handbill, one of the earliest relating to railway passenger traffic, is now of historical interest:—

STOCKTON & DARLINGTON RAILWAY.

THE COMPANY'S COACH

CALLED THE

EXPERIMENT,

Which commenced Travelling on Monday, the 10th of October 1825, will continue to run from *Darlington* to *Stockton*, and from *Stockton* to *Darlington*, every Day [Sundays excepted], setting off from the Depot at each place at the times specified as under, (*viz.*) :—

ON MONDAY,

From Stockton at half-past 7 in the Morning, and will reach Darlington about half-past 9 ; the Coach will set off from the latter place on its return at 3 in the Afternoon, and reach Stockton about 5.

TUESDAY,

From Stockton at 3 in the Afternoon, and will reach Darlington about 5.

On the following Days, viz. :—

WEDNESDAY, THURSDAY & FRIDAY,

From Darlington at half-past 7 in the Morning, and will reach Stockton about half-past 9 ; the Coach will set off from the latter place on its return at 3 in the Afternoon, and reach Darlington about 5.

SATURDAY,

From Darlington at 1 in the Afternoon, and will reach Stockton about 3.

Passengers to pay 1s. each, and will be allowed a Package of not exceeding 14 lb., all above that weight to pay at the rate of 2d. per Stone extra. Carriage of small Parcels 3d. each. The Company will not be accountable for Parcels of above £5 Value, unless paid for as such.

Mr. Richard Pickersgill at his Office in Commercial Street, Darlington ; and Mr. Tully at Stockton, will for the present receive any Parcels and Book Passengers.

The slow rate of speed of the early railway trains enabled persons whose greed was stronger than their morality sometimes to indulge in cheap if not costless rides. This was accomplished by jumping on the waggons when in motion, and leaping off the same before one or another of the stations had been reached. So frequent did these fraudulent acts become that notice was given, by placards posted along the line, that lawful penalties would be stringently enforced against offenders. It was surmised, possibly without any substantial foundation for the thought, that the engine-drivers of the coal and goods trains profited by a practice that was prejudical to the interests of the various coach proprietors, whose number had increased to seven in the year 1832. Each proprietor paid the duty then demanded by the State for the carriage of passengers, besides being required to have the ordinary license as a hackney coachman. A single horse was attached to each coach; the fares being respectively one penny for an outside passenger, and threehalfpence for an inside, per mile. These private owners conducted the passenger traffic until the year 1833, when the company bought up the rolling stock from the various parties, and thenceforward had the conveyance of travellers in its own hands. It is a fact worthy of notice that passengers were regularly carried by these coaches over a total length of 300,000 miles, and without injury to life or limb, during the seven years immediately following the opening of the first public railway.

CHAPTER VIII.

THE RAILWAY ENGINEER.

BEFORE his appointment as engineer to the Stockton and Darlington Railway, and while so engaged at the Killingworth and other collieries, Stephenson watched over the education of his son with the most anxious care. After attending Mr. Bruce's school in Newcastle for about four years, during which period he gave promise of his future distinction in the larger arena of life, Robert left his schoolmaster in order to be apprenticed to Mr. Wood, and thus learn the duties of a viewer. He was so employed for nearly three years, and became acquainted with the various departments of colliery work. The knowledge gained in this way was afterwards of great service to his father, as well as of advantage to himself; and during this time the daily intercourse between father and son, while it served to quicken the perceptive powers of the young man, also enabled the parent to obtain information on many points connected with the physical and other sciences of which he had previously known but little. The subject of the locomotive and its possible future engrossed, in their usual evening discussions, much of their attention and study. It is not surprising, therefore, that Robert Stephenson became, if possible, even

more enthusiastic than his father regarding the prospects of the locomotive and the rail.

Believing that a thorough training in technical science was necessary to an engineer's success in the higher branches of his profession, Stephenson determined to take his son from the duties of an under-viewer, which he then fulfilled, and send him to the University of Edinburgh. This was done in October 1822, while the Stockton and Darlington line was in course of progress. After a stay of six months in the Scottish metropolis, Robert returned to Killingworth with a prize for mathematics, which he had gained by his industry and ability. While serving his apprenticeship, he had various opportunities of witnessing improvements in colliery waggon-ways, as these were being carried out under the direction of his father upon one or another of the coal-lines of Northumberland or Durham, as well as during the reconstruction of the Hetton Railway, and the making of others. It was not, however, until the surveying of the Stockton and Darlington line that the "slight, spare, bronzed boy" was called upon to take any active part in the formation of a railway.

About the year 1821, the rapid expansion of the trade of South Lancashire caused the creation of further facilities in the transit of merchandise to be seriously entertained by commercial men. The cotton mills and their produce had of late increased so much that the ordinary channels of conveyance, the waggon and the canal, were found to be inadequate for meeting the demands made upon them. Greater speed in the delivery of goods was desired, and the passing of the Stockton and Darlington Railway Act, on the 19th of April in that year, concentrated public attention in these two great centres of industry to the project of a tramroad or railway between the important shipping mart of Liverpool and the "cotton metropolis." A Liverpool merchant, Mr. Sandars, took a leading part in bringing the

scheme to maturity. He instituted inquiry into the results of locomotive power, as employed on the private lines of the northern coal-field, and being satisfied therewith, he came to the conclusion that a public railway was desirable in the west, alike on utilitarian and economical grounds. His opinion was fully borne out by a treatise on the subject of a "General Iron Railway," which had been published by Thomas Gray of Nottingham about that time; the "Observations" in question having met with a large circulation, and aroused the thoughtful consideration of many people to the subject.

Having become prominently indentified with the Liverpool and Manchester Railway scheme, Mr. Sandars was associated in the work of projecting the line by Mr. William James, of West Bromwich, who had for some time taken an active interest in the laying down of tramways. At one time an iron manufacturer, engaged in a large business, James possessed considerable influence among gentlemen in the neighbourhood of Liverpool; although from having been unsuccessful in commerce, he now followed the profession of a land-agent and surveyor. The first survey of the proposed line was entrusted to him, and it was carried out with considerable difficulty, on account of adverse popular prejudices. While thus employed, it was not an unusual thing for Mr. James and his men to be met by parties of farm labourers armed with sticks, pitchforks, and even guns; prepared to dispute the passage of the surveyor and his assistants by a recourse, if necessary, to extreme violence. So fierce grew the opposition to the peaceful invaders of private grounds, that at length it was found necessary to call in the aid of a noted pugilist, whose special province it was to guard the theodolite used in the survey from destruction at the hands of an infuriated mob.

Upon two occasions Mr. James went to Killingworth,

where he saw one of Stephenson's locomotives at work, and was so pleased with his inspection both of the engine and the railway, that he promised to advise the adoption of a similar road between Liverpool and Manchester, and the employment of steam locomotion in the working of the line. Satisfied with his interview with Stephenson, James returned to Liverpool, but considerable delay occurred after his first survey had been completed, and it was found that another was required to rectify imperfections in the work. In this emergency, and in order to complete the plans and estimates for embodiment in the application to Parliament during the ensuing Session, Stephenson was asked to render the needed assistance, and Robert was despatched by his father to Mr. James for that purpose. In spite of the aid thus given, the surveyor was unable to fulfil his engagement to the committee, and that body was in consequence compelled to call in the services of an engineer to finish the plans and estimates for the line. The energy which had been displayed by Stephenson in the fulfilment of his duties to the Stockton and Darlington Company having attracted the attention of Mr. Sandars, and led him also to visit Killingworth, a conversation with the Northumberland engineer confirmed the opinion which the Liverpool projector had formed regarding Stephenson's ability, both from public rumour and private information.

On his return from Killingworth, Mr. Sandars reported to the committee the result of his journey, and strongly urged that Stephenson should be appointed their engineer. Effect being given to that recommendation, the committee proceeded with their new adviser to inspect the progressional works of the Stockton and Darlington line, after which the party journeyed to Killingworth, where the locomotives were tried under various conditions; all of which tests satisfied the gentlemen present, and they determined to recommend that a company should be at once formed for carrying the

scheme for a railroad between Liverpool and Manchester to completion. The first prospectus of the company was dated the 29th October, 1824, and advocated the construction of the line "as a cheap and expeditious means of conveyance for travellers;" holding out the fair prospect of a public accommodation, the magnitude and importance of which could not be immediately ascertained.

The shares in the new company having been speedily taken up, the directors and their engineer made the necessary arrangements for presenting their Bill to Parliament in the Session of 1825. Before drafting the proposed measure, however, further steps were taken to remove doubts which still existed in the minds of some of the projectors as to the practicability of using locomotives on the railway when completed. For that purpose a second visit to Killingworth was undertaken by the committee, which was soon after followed by a third. The latter journey was made in January, 1825, and the gentlemen connected with the company who formed that third deputation to the scene of George Stephenson's early mechanical successes were accompanied by consulting engineers, in order that the committee might receive advice from men of practical experience, in any future deliberations upon the question of adopting the still doubtful travelling engine as a motive power.

One of the first effects of the projection of the Liverpool and Manchester Railway was an offer of conciliatory proposals by the canal companies, who had hitherto had the monopoly of conveyance between the two towns, and who had frequently turned their exclusive position to account by charging exorbitant freights for the services which they rendered to trade and commerce. Hitherto these monopolists had ridiculed the idea of railways ever becoming serious opponents to their extortionate exactions. Now the case was altered. The Stockton and Darlington line would

speedily be opened for traffic, and the utility of public railways might soon be no longer a matter of conjecture but of established fact. Under the circumstances, therefore, it was policy to endeavour to conciliate traders by lowering the canal rates, and by promising to introduce steam power in the water-carriage of merchandise. But the die had been cast; offers of conciliation came too late; and the promoters of the second public railway resolved to prosecute the scheme, until success crowned their efforts.

Finding the advocates for railway accommodation thus determined, the canal companies circulated pathetic appeals for the purpose of inciting public opposition to the proposed line. The newspaper press, too, was employed to write it down. The occupiers of houses along the intended route were assured that their property would inevitably be consumed, by being set on fire through the plentiful distribution of red hot cinders from the hateful locomotives. Horses would become extinct were railways to extend throughout the country. The preservation of game would be impossible. Hens would refuse to lay; cows would be unable to yield their milk for the use of man; fox-hunting would be a thing of the past. There was but one element out of which the prophets of evil formed matter for congratulation to themselves: those who had the temerity to travel by rail would be blown in pieces through the bursting of boilers—always provided that the weight of the engine permitted people to travel at all!

In the face of opposition, ridicule, and abuse, George Stephenson carried out his survey. Now, he was being threatened with immersion in a duck-pond; then, his levelling operations were stopped by a number of armed gamekeepers. The agricultural classes looked upon the north-country engineer as a fiend incarnate, who had entered upon a mission of extermination for their especial harm. Some landed proprietors regarded him with feelings of

unmitigated hatred. Others looked upon him as a maniac, whose condign incarceration in a lunatic asylum was alike demanded in the interests of society and the owners of estates. In general estimation he was a social Ishmael, whose hand was against every man's, and whom it was the duty of every man to oppose by means fair or foul. Writing to Mr. Joseph Pease, on October 19th, 1824, Stephenson said:—"We have sad work with Lord Derby, Lord Sefton, and Bradshaw, the great canal proprietor, whose grounds we go through with the projected railway. Their ground is blockaded on every side to prevent us getting on with the survey. Bradshaw fires guns through his grounds in the course of the night, to prevent the surveyor coming on in the dark. We are to have a grand field-day next week. The Liverpool Railway people are determined to force a survey through, if possible. Lord Sefton says he will have a hundred men against us. The Company think those great men have no right to stop a survey; it is the farmers only who have a right to complain, and by charging damages for trespass, it is all they can do." Depressed, disheartened sometimes, but with unfailing faith in the ultimate triumph of his foster-child, the locomotive, George held courageously on his rough and difficult path, till at length his survey was completed, and the Liverpool and Manchester Railway Bill was set down for argument before a committee of the House of Commons.

The counsel for the promoters of the line were Mr. Adam, Mr. Serjeant Spankie, Mr. William Brougham, and Mr. Joy. The opponents of the Bill were represented by Mr. Alderson and Mr. Parke, both of whom became Barons of the Exchequer, and by Messrs. Harrison, Erle, and other counsel of note. After a month had been occupied in taking evidence as to the difficulties experienced by traders in the conveyance of their goods to and from the towns which were to form the termini of the proposed railway, Stephenson

was called as a witness for the engineering phase of the question before the Parliamentary Committee. If his statements could be shown to be devoid of probability, or were otherwise unworthy of credence, then the Bill was doomed. The odds were fearfully against the self-tutored enginewright from Northumberland as he stood within the witness-box at Westminster; for how could he hope, single-handed, and in the broad dialect of a northern village, to contend against the forensic acumen and eloquence of such distinguished London barristers as were arrayed against him? Besides, he had gone to St. Stephen's for the purpose of turning society upside down, and society had a right to object to the action—especially when the performer was a nobody who hailed from the dusky neighbourhood of a coal-pit, and who spoke an outlandish gibberish that genteel people cared not to understand!

Confronted by the sneers and ridicule of the opposing advocates, by whom he was subjected to repeated interruptions, George told the artless tale of his experience as a colliery brakesman, from the year 1803 when he removed to Killingworth. Step by step he traced his gradual rise from the position of a manual workman to that of a railway engineer. Sometimes with a struggle for utterance which gave his enemies a momentary gleam of hope that he had broken down, he recapitulated the various improvements which he had carried out upon the lines immediately under his charge; the railways which had been constructed or were in progress under his direction at Burradon, Mount Moor, Springwell, Bedlington, Hetton, and Stockton; with the engines which he had designed and built, thirty-nine of which were stationary, and sixteen locomotive. With a perceptible feeling of pride he spoke of the Killingworth line and its travelling engines, which had worked thereon with great efficiency for eleven years.

His plans for the line formed subject-matter for a cross-

examination of the most searching character, for throughout his experience he had never been called upon to deal with engineering difficulties of such formidable proportions. The details of bridges, crossings, gradients, and tunnels were all used with bewildering iteration to confuse the witness and shake his credibility, by extracting from him answers to questions of which he had not caught the purport. Upon the point of speed, some members of the committee entertained views of a very cautious nature, which the counsel for the opposition were not slow to take advantage of in the interests of their clients. When years had elapsed, and railways were regarded as public necessities, Stephenson referred to his appearance at this time as a Parliamentary witness in the following terms:—"I pledged myself to the directors to attain a speed of ten miles an hour. I said I had no doubt the locomotive might be made to go much faster, but that we had better be moderate at the beginning. The directors said I was quite right; for that if, when they went to Parliament, I talked of going at a greater rate than ten miles an hour, I should *put a cross upon the concern.* It was not an easy task for me to keep the engine down to ten miles an hour, but it must be done, and I did my best. I had to place myself in that most unpleasant of all positions—the witness-box of a Parliamentary Committee. I was not long in it before I began to wish for a hole to creep out at! I could not find words to satisfy either the committee or myself. I was subjected to the cross-examination of eight or ten barristers, purposely as far as possible to bewilder me. Some member of the committee asked if I was a foreigner, and another hinted that I was mad. But I put up with every rebuff, and went on with my plans, *determined not to be put down.*" Mr. Nicholas Wood, who was present during Stephenson's examination as to the possible speed of locomotives, afterwards gave it as his opinion that if twelve or fifteen miles had been stated as

practicable, not a single person present would have believed the announcement!

The opponents of the Liverpool and Manchester Railway Bill had a mute but eloquent advocate in their behalf, and they did not fail to use it to advantage. Chat Moss, a peat bog extending to about twelve square miles, and in the direct line of the railway, offered an argument of the most convincing character against the scheme. Mr. Harrison, one of the opposing barristers, thus accurately described it:—"Chat Moss rises in height, from the rain swelling it like a sponge, and sinks again in dry weather; and if a boring instrument is put into it, it sinks immediately by its own weight. The making of an embankment out of this pulpy wet moss is no very easy task. Who but Mr. Stephenson would have thought of entering into Chat Moss, carrying it out almost like wet dung? It is ignorance almost inconceivable. It is perfect madness in a person called upon to speak on a scientific subject to propose such a plan."

The idea of working the traffic over the proposed railway by means of locomotives was thus ridiculed by the same learned gentleman:—"When we set out with the original prospectus, we were to gallop, I know not at what rate; I believe it was at the rate of twelve miles an hour. My learned friend, Mr. Adam, contemplated—possibly alluding to Ireland—that some of the Irish members would arrive in the waggons to a division. My learned friend says that they would go at the rate of *twelve miles an hour*, with the aid of the devil in the form of a locomotive, sitting as postilion on the fore horse, and an honourable member sitting behind him to stir up the fire, and keep it at full speed." The learned counsel then attempted to prove that it was *impossible to attain a speed of six miles an hour!* The following was one of the reasons which he gave in support of his theory. He said:—"Locomotive engines are

liable to be operated upon by the weather. You are told they are affected by rain, and an attempt has been made to cover them; but the wind will affect them; and any gale of wind which would affect the traffic on the Mersey would render it impossible to set off a locomotive engine, either by poking of the fire, or keeping up the pressure of the steam till the boiler was ready to burst."

The testimony of civil engineers of eminence fully bore out the taunting criticism of barristers. "No engineer in his senses," said one of these gentlemen, "would go through Chat Moss if he wanted to make a railway from Liverpool to Manchester." With such an opinion expressed on professional authority, Mr. Alderson was justified in employing all the resources of his legal ability and great eloquence in a two days' speech against the Bill. He declared the scheme to be the most absurd that ever entered into the head of man to conceive. A majority of the committee believed the statement of the learned counsel; and the measure was withdrawn after a bitter and determined contest extending over two months.

The prospect held out to Stephenson after this crushing defeat was indeed a dark one. At various times during the proceedings he had been dubbed a madman and a fool, and even his friends had wavered in their faithfulness towards him. His disappointment and chagrin were intensified when he found that the projectors of the railway had resolved to renew their efforts in another Parliamentary Session, but had expressed their intention to call to their aid engineers only of the most distinguished status and repute. That was done by the appointment of Messrs. George and John Rennie to the position which Stephenson had lately filled, and these gentlemen proceeded to carry out another survey.

But the Killingworth engineer, the locomotive and the railway, were soon to emerge from the cloud which enveloped

them. On the completion of the new survey, the plans were prepared, and a second Bill was presented to Parliament, which passed without any undue protraction of the arguments or examination of witnesses. This result was effected mainly through the measures which were taken by the promoters to conciliate the favour of their most formidable opponents. By so altering the route as to render inviolate the precincts of certain estates, the antagonism of the owners was withdrawn; while a questionably generous concession was made to popular prejudice against the locomotive, by *offering* to eliminate from the Bill any clause which would empower the company to use travelling engines upon the line.

Having obtained powers to construct the railway, the appointment of the chief engineer next engaged the consideration of the directors, and they decided to continue the services of Messrs. Rennie, in order that these gentlemen might superintend the operations, while to Stephenson would be given the post of resident engineer—a subordinate position, but one, under the circumstances, which demanded in its holder the possession of considerable ability and practical experience. But professional etiquette interposed a barrier to that arrangement; Mr. George Rennie stipulating for the appointment to the inferior office to be left in his own hands. To that stipulation the directors could not agree, and so the principal engineership was offered to Stephenson, with its emolument of £1000 a-year. The offer was accepted, and he removed to Liverpool, where he at once made arrangements for carrying out his stupendous undertaking.

CHAPTER IX.

THE VICTORY OF THE "ROCKET."

WHEN Stephenson entered upon his duties as engineer-in-chief of the Liverpool and Manchester Railway, he had no trained staff of assistants or draughtsmen. As resident engineers, he selected John Dixon, whose connection with the Stockton and Darlington line has already been noticed, Joseph Locke, and William Allcard. To these gentlemen were allotted the three sections into which the railroad was divided—the former having charge of the most difficult portion, namely that over Chat Moss. After taking an active part in the organisation of the Forth Street Engine Works, Robert Stephenson had sailed for South America, in June 1824, having being engaged by the Columbian Mining Association to direct the operations of that company at Mariquita. George Stephenson was thus left to face the difficulties of his new position without that aid which his promising son would undoubtedly have been able to render had he remained in England. The principal draughtsman, Thomas Gooch, was one of a number of pupils who were employed in office-work, and in learning their profession under the first railway engineer. Gooch also acted as Stephenson's

secretary, and was able to bear personal testimony to the unflinching zeal and perseverance of his chief. "Like master like man," was an adage which was amply illustrated in the careers of Stephenson's pupils, for they all, without exception, attained distinction in their profession, and severally exemplified the teaching of their instructor, whose frequent advice to the young men was:—"Learn for yourselves; think for yourselves; make yourselves masters of principles; persevere, be industrious: and there is then no fear of you."

Chat Moss, that huge peat bog, tried to the utmost the patience, energy, or skill of all who were concerned in carrying a railway across its pulpy, spongy surface. For ages, year by year, mosses had grown and withered—the partially decayed stratum of one season forming a bed for the growth of the following, until the whole made up a submerged mass of soft slimy peat, with a depth of from twenty to thirty feet, and extending over an area of about twelve square miles. While some engineers of eminence had pronounced the construction of a railroad over such a foundation to be wholly impracticable, others had fixed the cost of the line at a figure which would have destroyed any prospect of interest being earned in return for the invested capital, had the estimates proved at all accurate. Undaunted by the unfavourable opinions of others regarding his plan, or the formidable nature of the task itself, Stephenson commenced the operations. Throughout the progress of the work his whole bearing and conduct formed a practical commentary upon his own homely precepts:—Learn for yourselves; think for yourselves; master right principles; persevere, and be industrious!

The theory conceived by the engineer, and upon which he designed to carry the line over Chat Moss, was that of a *floating roadway* of sufficient strength and buoyancy

to carry the rails and their moving weights securely. The digging of drains along the sides of the proposed line was first attempted, but soon had to be abandoned in many places on account of the trenches quickly filling up with the slushy material through which a cutting had been made. In the endeavour to form a pathway for the workmen and boys engaged, the engineer was more successful. A thick platform of broom or heather, laid upon the surface of the Moss, constituted the foundation upon which were laid the temporary sleepers necessary for the rails. Along the railroad thus formed the materials required for making the permanent way were carried in waggons propelled by boys. The principle of the permanent road was but an extension of that of the temporary waggon-way; the foundation of the line on the softest portions of the Moss being constructed by intertwining heather between the bars of strong wooden hurdles, which were laid down as a bed for the sleepers, drains, and rails. To prevent any undue sinking of the railroad at these slushy parts, the spaces between the sleepers were packed with dried peat or heather, instead of ballast or gravel, as is usual in the construction of ordinary railways.

Never at a loss for an expedient when beset by a difficulty, Stephenson caused tar barrels to be laid down on either side of the Chat Moss railroad, at parts where the wet nature of the bog interfered with the cutting of drains. The barrels were placed end to end, and properly secured, so as to form wooden sewers for the drainage of the line. This device had the desired effect, but a more formidable difficulty presented itself when a junction between the floating road and *terra firma* came to be wanted. For a distance of four miles the railway was upheld by its own buoyancy, like a long strip of cork on the wet and spongy heath. Now the ends of the strip must be firmly joined to the solid ground on the extreme edges of the Moss. At

the edge nearest to Liverpool that was effected with but little difficulty. The Manchester end of the floating line was not, however, so easily secured. Thousands upon thousands of cubic yards of earth and dried peat were thrown into the insatiable bog, but without apparent effect. This went on for weeks, but no trace of an embankment appeared to reward the directors and engineer for their outlay and labour. The projectors naturally grew impatient at what seemed to be a fruitless expenditure of capital. Those who had sneered at the courageous idea, and ridiculed the engineer with whom it had originated, were now jubilant at the prospect held out of a veritable fulfilment of their prognostications. Stephenson was taken to task one day by an over-zealous director of the company, who instanced the energy of the great Napoleon as worthy of imitation by the engineer in such a crisis as he then found himself. Stephenson's reply was characteristic of the man: "Never mind Napoleon! With money, materials, and men, I can make a railroad over Chat Moss. We must keep filling in. There is nothing else for it. The stuff is doing its work out of sight, and it will soon show, *if you will only have patience!*"

Many railways of later date than the one between Liverpool and Manchester afford examples of the successful accomplishment of greater engineering tasks. It is true that the scheme of a line over Chat Moss was declared utopian by many who were qualified to express an authoritative opinion. The Sankey Viaduct, with its nine arches, each of fifty feet span; the Olive Mount Cutting, the depth of which is in some parts eighty feet, while its rocky length extends to nearly two miles; the Liverpool Tunnel, hewn and blasted through solid rock, or cut through beds of yielding sand, for a distance of two thousand two hundred yards: these undertakings all demanded great ability in their designer and constructor. All have been repeatedly

eclipsed, however, by more modern achievements in engineering. But it should be borne in mind that when the Killingworth engine-wright entered upon the practical portion of his duties at the time now under review, he had not only to devise and provide the accessories and implements necessary to a railway contractor, but he was also called upon to organise and drill a band of navvies specially for the work of railway making. For that end the practice he had acquired as a ballast-heaver at Willington Quay peculiarly fitted him. He had not forgotten the art of handling a shovel effectively. The railroad navvy can trace his history no further back than the time of George Stephenson, who first taught him the use of the pick, the shovel, and the barrow.

Besides the smaller details of stations, bridges, girders, crossings, and sidings, and larger works connected with the permanent way, which were for the most part planned under his immediate direction, Stephenson had to design fixed engines and rolling-stock for the working of the railway. It was not until the line was considerably advanced that the directors seriously debated the question of using locomotives. A deep-seated prejudice existed in the minds of many regarding the travelling engine. The Stockton and Darlington Company had experienced some difficulty with proprietors whose estates joined that line, in regard to the excessive quantity of cinders which "Locomotion" and its companion "Hope" emitted from their funnels. Law proceedings had resulted from the alleged nuisance. The minority of the directorate who opposed the introduction of the locomotive upon the second public railway had some show of reason, therefore, for the opposition in the bad repute of the engines upon the South Durham line. But amid the harassing work of his every-day life, Stephenson found time and energy to fight the battle of his favourite motive power, and he proved successful in the encounter.

At the urgent request of his father, Robert Stephenson returned to England in 1827, and at once assumed the direction of the affairs of the Engine Works at Newcastle-upon-Tyne, which had been allowed to get into confusion during his absence. At one time the prospect of success for the manufactory appeared so hopeless that the stoppage of its operations had been seriously entertained. But now, with his son reinstated in his old position as manager, the engineer of the Liverpool and Manchester Railway felt that could he but succeed in getting his directors to try the locomotive for themselves, and upon their own line, its ultimate triumph was assured. In order to attain the consummation of his great desire, he never let slip an opportunity for urging the matter upon the attention of those who were most disinclined to give their consent to his project. In season and out of season he pressed forward the claims of his foster-child, until at length, wearied by incessant importunity, the Board ordered a travelling engine to be built, in order, as Stephenson alleged, that it might transport expeditiously from one point to another, as might be required, the various materials used in the construction of the line. That locomotive was forwarded from Newcastle in 1829, and the work performed by it justified the advice which had been given by the engineer.

With an engine travelling upon their own railway now rapidly nearing its completion, one might have imagined that the question of its utility, or the reverse, could have been easily determined by the directors. Not at all. The inventive genii of Great Britain and other countries seemed to have conspired to harass and bewilder the unfortunate gentlemen, who were deluged with all sorts of schemes for the propulsion of their future trains. Worn out by the continual applications, correspondence, interviews, advice, and journeys of inspection which they had to undergo, as well as by the persistency of their chief engineer, the

directors finally succumbed to the inexorable decree of fate, and a prize of £500 was offered for a locomotive which should be proved upon trial to have fulfilled the following conditions, which were publicly circulated :—

"The engine must effectually consume its own smoke. If of six tons weight, it must be able to draw, day by day, twenty tons weight (including the tender and water tank) at ten miles an hour, with a pressure of steam on the boiler not exceeding fifty pounds to the square inch. The boiler must have two safety-valves, neither of which must be fastened down, and one of them be completely out of the control of the engineman. The engine and boiler must be supported on springs, and rest on six wheels; the height of the whole not exceeding fifteen feet to the top of the chimney. The engine, with water, must not weigh more than six tons; but one of less weight would be preferred, on its drawing a proportionate load behind it; if only four-and-a-half tons, then it might be put on only four wheels. The company to be at liberty to test the boiler, etc., by a pressure of one hundred and fifty pounds to the square inch. A mercurial gauge must be affixed to the machine, showing the steam pressure above forty-five pounds per square inch. The engine must be delivered, complete, and ready for trial, at the Liverpool end of the railway, not later than the 1st of October 1829. The price of the engine must not exceed £550."

Although many attempts had been made by several hands to fulfil the requirements announced by the directors, only four steam locomotives were present on the ground allotted for the trial when the day appointed dawned. Various causes conduced to that result. In some instances engines had been constructed, which, upon examination, were found to be so defective in principle as to render the chances of their success very small indeed, and the machines were consequently not entered for competition. In other cases, repeated alterations had delayed the finishing of engines, until the time limited for entry had expired. The four exhibited were the "Novelty," "Sanspareil," "Rocket," and "Perseverance," built respectively by Messrs. Braithwaite & Ericsson, Timothy Hackworth, R. Stephenson & Co., and Burstall.

The memorable trial of locomotives at Rainhill began on the 6th of October 1829, and extended to the 14th, on which day the prize was awarded. Although not the first on the list for competition, Stephenson's "Rocket" was the earliest to be ready for starting, and it was accordingly ordered by the judges to proceed on a preliminary trip. Neither the gentlemen more nearly concerned in the trial, nor the spectators in general who witnessed it, were at all prepossesed in favour of the engine from Newcastle. Its appearance was against it. It looked as if it were all funnel—a stunted body with a long, very long neck. Along a level stretch of railroad, two miles long, each engine was required to make twenty double journeys during the day, at an average speed of not less than ten miles per hour. The first trip of the "Rocket" was quite satisfactory, as it accomplished the distance of twelve miles in about fifty-three minutes. Still, as people said, its appearance was against it.

The second engine ordered out by the judges was of a totally different character. It looked compact and handy, and its lines were harmonious and in keeping with the purpose for which it had been built. The "Novelty" was not only a favourite with the dense crowd of spectators, but the majority of the judges were also disposed to regard it with preference. Its water and fuel were carried without the aid of a separate tender, and the weight of the whole was but a little over three tons. While travelling its experimental journey, it occasionally moved at the rate, per hour, of twenty-four miles.

Timothy Hackworth, the designer of the "Sanspareil," which next passed in review before the judges at Rainhill, laboured under great disadvantages in the construction of his locomotive. He was a man far in advance of his time; and George Stephenson, upon more than one occasion, was indebted to his friend for sound practical advice when beset

by engineering difficulties. Trained under William Hedley at Wylam, Hackworth had acquired strong sympathies in favour of the travelling engine; and when the competition was advertised, he at once took steps to enter an appearance with an engine that would not disgrace the future reputation of its contriver. But he had not the facilities for carrying out his idea without the assistance of others. He was at that time resident engineer and manager of the Stockton and Darlington Railway, and his duties in that capacity prevented him from giving that personal oversight to the building of the "Sanspareil," the want of which, in all probability, told greatly against that engine's efficiency at the trial. The cylinders were made by R. Stephenson & Co.; the boiler at the Bedlington Iron Works.

The second day of the contest was marked by the failure of the blast-bellows of the "Novelty"—a contrivance that was unique in its way, but one that constituted a weakness in the neatly-built and favourite engine—and it could not in consequence be exhibited. The boiler of the "Sanspareil" also showing a defect, Hackworth's locomotive had to be withdrawn for a time in order to be repaired. As for the "Perseverance," it was unable to travel faster than six miles an hour, and had therefore failed in the important condition regarding speed.

One of the four competitors having thus been definitely disposed of, and two undergoing repairs, considerable dissatisfaction began to be manifested by the crowd which had again assembled to witness the singular spectacle of a locomotive race. Stephenson noticed the gathering storm, and immediately endeavoured to allay popular feeling by running out the "Rocket," to which was attached a passenger coach. Into the latter thirty persons were huddled without much ceremony; and the engineer himself acting as driver, the engine at once started along the line at the rate of nearly thirty miles an hour. That performance astonished alike

the travellers, the spectators, and the judges. It was not, however, until the following day, the 8th of October, that Stephenson's bald and unpopular locomotive made any decided progress in public favour.

In its final trial the "Rocket" more than sustained the character which had been expected from it by its designer. With a load of thirteen tons weight in waggons, travelling alternatively forwards and backwards along the two-mile course, the engine accomplished a distance of thirty-five miles, with the necessary stoppages for reversing the motive gearing, in one hour and forty-eight minutes. A second journey of the same length was performed in fourteen minutes longer than the first series of trips. The average velocity attained over the whole seventy miles was fifteen per hour; the maximum speed for the same time being twenty-nine. Ere the task of the "Rocket" had been concluded on the third day of the competition, people discovered excellencies in the hitherto despised travelling engine that were not before apparent to the popular eye. In short, as some one said, "*She did not look so bad after all!*"

The "Novelty" having been repaired, was again tried upon the 10th of October, when its appearance and style of working as it started upon the first trip for that day, gained for it a renewal of some portion at least of the partiality which it had lost through its mishap. But the sudden bursting of one of its pipes ended the hopes of its owners and their chance of gaining the offered prize. Three days afterwards, the "Sansparcil" was similarly unfortunate; for during the eighth trip, made at the average rate of fourteen miles per hour, the engine broke down through a failure in its water-pump, and the prospects of success for Hackworth's engine were also at once extinguished.

The "Rocket" being the only competing locomotive which had fulfilled the stipulations in terms of which the trial was

conducted, R. Stephenson & Co. were declared to be the winners of the prize of £500. That the public concurred in the verdict of the judges, is apparent from the shares of the company immediately rising in value to the extent of ten per cent. The "Sanspareil," although it did not gain for its designer much credit during the memorable trial, was nevertheless a good and serviceable engine, as will be seen in the fact that it was employed for many years upon the Bolton and Leigh Railway. The following notice of the famous "Rocket" and its veteran progenitor, "Puffing Billy," of Wylam celebrity, appeared in the *Illustrated London News* of the 15th of October 1864:—

"On the south side of the Museum are a couple of locomotive engines—old, very old—worn, bent, bruised, and rusty, but full of interest; for one is the oldest locomotive engine in existence, the parent of all that have since been produced—the original old 'Puffing Billy' of the Wylam Colliery, constructed there, in 1813, by William Hedley for Christopher Blackett, whose name will ever be remembered as one of the earliest and staunchest friends of the locomotive. This 'Puffing Billy' was not the first engine of Mr. Blackett. He had tried Trevithick's and other inventions, and had been nearly blown up several times, but at last this homely-looking, sturdy machine was perfected, and from that date—1813—up to a comparatively recent period, it has been dragging—very slowly, it is true—heavy loads of coals and waggons to and fro. It has a battered, and bruised, and hard-worn look, with indubitable marks of extreme old age about it; but it was a good, hard-working, willing drudge, and has well-earned the quiet time it will have in future here in the Kensington Museum. Upon one side of it hangs a document, dated 1815, from which it appears some great objection had been made by local landowners to the puffing propensities of the aforesaid 'Billy,' and a case is referred for opinion to a barrister, named Williams, whose opinion is that there is no objection, arising from the lease itself, to Mr. Blackett conveying his coal-waggons by means of this steam-engine; but he thinks that the use of such an engine may be deemed a nuisance if the smoke or noise of the engine disturbs the cattle grazing on the lands adjacent to the waggon-way. The locomotive had a narrow escape of being put down as a common nuisance. We might now as easily think of putting down earthquakes or eruptions of volcanoes as putting down the loco-

motive engine; but in those days it was different, and had an extinguisher been put on 'Puffing Billy' at that time, the introduction of locomotives and railways for passenger traffic might have been delayed for many years. Beside this venerable specimen of mechanical ingenuity stands another locomotive engine, worn, bruised, strained, and cracked like its neighbour, but not so old as 'Puffing Billy,' which dates as far back as 1813, while this did not come into existence until the year 1829. These engines are well placed side by side, for the spectator may, by looking at them in such a position, easily come to several important conclusions. In designing the old engine, it is evident that its inventor never dreamed of any speed worth thinking of. To crawl along, with a heavy load behind it, was all that this engine was expected to do, and it did this patiently, but with a great deal of fuss and clatter, for half-a-century; and for such a performance, and considering its extreme old age, it is entitled to our highest respect. But, turning to its neighbour, we see that its inventor and constructor did think of high speed; there is a wonderful look of speed about it, and it did actually travel at forty miles per hour, for it is the celebrated 'Rocket' engine of George Stephenson, the parent engine of our present locomotive system. This is really a very interesting relic, for it was the great starting-point of high speed and passenger railways."

The victory of the "Rocket" effectually silenced the clamour of the more bitter opponents of the railway system. It also settled the vexed question of the application of steam locomotion for passenger traffic. True, many could not overcome their prejudice against the new mode of travelling; but such persons soon found themselves in a most unenviable minority. The tables had been turned, and the opponents, not the advocates, of railroads were regarded as fit and proper candidates for admission into asylums for the insane!

CHAPTER X.

THE TRIUMPH OF THE RAILWAY.

WHILE the Stockton and Darlington line was in course of construction, its engineer uttered a prophecy regarding the future of the railway system. Addressing his son Robert, and his assistant John Dixon, George Stephenson said :—"Now, lads, I venture to tell you that I think you will live to see the day when railways will supersede almost all other methods of conveyance in this country: when mail-coaches will go by railway, and railroads will become the great highway for the King and all his subjects. The time is coming when it will be cheaper for a working-man to travel upon a railway than to walk on foot. I know there are great and almost insurmountable difficulties to be encountered, but what I have said will come to pass, as sure as you live. I only wish I may live to see the day, though that I can scarcely hope for, as I know how slow all human progress is, and with what difficulty I have been able to get the locomotive thus far adopted, notwithstanding my more than ten years' successful experiments at Killingworth." Much of that prophecy has already been fully accomplished. The portion which relates to the

cheap conveyance of the working classes has only been partially fulfilled!

The completion of the Liverpool and Manchester Railway was considered an important national event. By the 1st of January, 1830, a single line of rails had been laid down throughout the whole distance; and on the 15th September of that year the opening ceremony took place, the railway being then finished and ready for traffic. The Duke of Wellington, who was Prime Minister, honoured the occasion with his presence; as did also the Home Secretary, Mr. Peel, and an immense number of distinguished personages. Many scientific gentlemen of this and other countries were likewise present to satisfy themselves by ocular demonstration, that what had been considered to be impossible had actually been performed, through the indomitable energy, industry, and perseverance of a humble, self-taught enginewright, from a small, out of the way colliery village in Northumberland!

A sad calamity marked the inauguration of the line. Eight locomotives, which had been built at the Forth Street Works, formed, with their several trains, an imposing procession that was cheered vociferously by the thousands who watched its progress. On arriving at Parkside, seventeen miles from the starting-point at Liverpool, the leading engine, called the "Northumbrian," and attached to a carriage which contained the Prime Minister, drew up on one line, so that the trains which followed might pass along the other in review before his Grace. Mr. Huskisson, one of the members of Parliament for Liverpool, and who had taken much interest in the projection of the railway, suddenly crossed the rails for the purpose of speaking to the Duke, when the "Rocket" was seen approaching rapidly. The warning cries of the bystanders only served to confuse the honourable gentleman, and before he could recover his presence of mind, and step clear of the line, the engine

was upon him, inflicting injuries from which he died a few hours after the accident. Notwithstanding the gloom cast by that melancholy circumstance, the triumph of the railway system had been assured.

A large passenger traffic immediately sprang up to reward the directors for their outlay, and to demonstrate the soundness of George Stephenson's conclusions. The stage-coaches running between Liverpool and Manchester had carried on an average about four hundred and fifty persons per day. It was calculated that half that number might be induced to transfer their custom to the railway, but the line had only been opened a very short time when the daily number of passengers was found to exceed twelve hundred! Even in the first year of its existence, the railway which had been prophecied to be fraught with devastation to property and ruin to shareholders, earned an annual profit of eight thousand pounds; while the adjoining land rose so much in value, by reason of such proximity, that when the company required to purchase some ground for the extension of stations and sidings, it was found that the price had increased considerably.

The Liverpool and Manchester Railway, in its projection and construction, had been the field upon which the battle for and against the locomotive had been fought. The visitors followed up their success by engrafting upon each new engine placed upon the road the latest improvements which their growing experience suggested. It had been incontestibly shown that a railway could be made over ground presenting great natural obstructions to the work of the engineer. It might have remained for financial results slowly to determine whether the extension of the system should be proceeded with, or otherwise left as an open question for the future to decide. But speculators were encouraged by the brilliant prospect that was at once disclosed by the completion of the Liverpool and Manchester

line to embark without much delay in fresh undertakings. Railroads were speedily projected between the great centres of industry and wealth; while the profession of a railway engineer offered dazzling inducements to many, whose qualifications were fanciful or real, to enter its ranks. The name of George Stephenson, however, had become as a household word in connection with the new medium of transit, and his services were not only in demand for the great lines which were proposed in his own country, but continental railway companies sprang up also to claim an interest in his genius and ability.

His sterling honesty and sound common sense were conspicuous during the period of the railway mania which infested English society in the years 1845–46. Intoxicated with the desire to get rich, or richer at a bound, men lost their mental equilibrium, and plunged into the wildest of schemes. To the honour of Stephenson's memory be it said that no shareholder could ever trace his own ruin, or the beggary of his family, to the collapse of a specious project to which the great engineer had lent his name. "Will such a line pay?" was the invariably first question which he endeavoured truthfully to answer. Engineering difficulties were accounted by him as but of secondary moment. Whenever he could not satisfy his mind that any new venture offered a reasonable expectation of success financially, he at once, regardless of selfish interest or of consequences to others, gave it his uncompromising opposition. Thus we find him holding aloof from all the reckless schemes that were put forward by too sanguine or unprincipled promoters. Although he was frequently offered considerable sums, if only he would allow his name to appear in the prospectus of a dubious project, he stedfastly refused to truckle to dishonesty. George Stephenson would always render solid service for adequate payment. He never touched a questionable bribe.

The harassments and rebuffs which he had endured while fighting the battle of the locomotive and the rail had impaired the natural kindness and sympathy of his disposition to some extent, and rendered him at times, previous to the hour of his great triumph, particularly sensitive of the slightest opposition to his wishes: irritable, impatient, exacting. But after the opening of the second public railway—when the feverish fervour of open foes had been transformed into the fawning flattery of so-called friends—his former amiability and genial temper returned, and continued to be conspicuous traits in him until the closing scene in his eventful life. Not that he was susceptible to the adulation of such as are ever ready to run to the assistance of a man when he requires no help. Stephenson could estimate such a favour at its true value. But having attained the great object for which he had struggled and toiled, almost unaided and alone, he could now look with comparative complacency, if not indifference, upon all the troubles and trials incident to his position.

Associated more or less with his son Robert, Stephenson continued to devote his surpassing powers of mind and energy to the development and extension of railways, English and Continental, until he settled at Tapton Hall, near Chesterfield, in the year 1840, when he gradually withdrew from active employment in his profession. Naturally too active to be long idle, he engaged in various mining speculations, in some of which he was tolerably successful. The world having come round to his way of thinking, society sought to draw him into the circle of its pleasures and influences; but his habits and tastes were of the simplest, and it was a difficult matter to induce him, even occasionally, to leave his retirement, and associate with the elevated or distinguished personages of his time. The evening of his life was marked by that excessive fondness for birds and animals which had characterised the early

morning of his existence. In the pairing season, there was not a nest within his ample grounds which he did not visit daily. In horticulture he became an enthusiastic adept, and his inherent ingenuity was frequently called into requisition in devising means for perfecting the growth of his fruits and flowers. He was earnest and thorough in all that he undertook; and the same determination which had enabled him at middle age to carry on a warfare against popular prejudice, timidity, and distrust, led him at the decline of life to try to excel others in the growing of cucumbers, grapes, and pineapples. In the prosecution of what became to him a favourite pastime, he spent much time in the noxious atmosphere of his forcing-houses. The hurtful character of such employment upon his constitution, which had been enfeebled by a severe attack of pleurisy, became too painfully apparent to his friends in the summer of 1848. On the 12th August of that year his spirit departed from its bodily tenement. His death, which occurred in the sixty-seventh year of his age, was immediately attributable to an intermitting fever of a few days' duration.

To the distinguished ingenuity, untiring industry, and invincible resolution of George Stephenson, the world mainly owes the advantages which have accrued from the improvement of the locomotive and the triumph of the railway. Although the grand idea of steam locomotion did not originate with the Killingworth engine-wright, and although others were also engaged in the endeavour to solve the momentous problem, it must be conceded that he brought the question to a successful issue, and not only demonstrated the practicability of railroads, but the economy also which their adoption would effect. For many years he stood forth as the sole advocate of a system of public conveyance that was destined largely to dispel the jealousies which had long subsisted between nationalities, and to

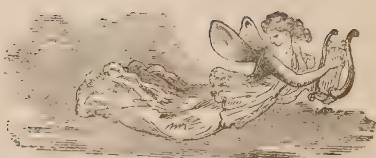
change for the better the social condition of the class from which he had sprung.

By diffusing a healthy spirit of enterprise among the capitalists of his own country, George Stephenson exhibited to the people of other lands the superiority of peaceful projects over warlike wastefulness. The railway has effected what the might of Imperial Rome could never achieve. It has brought civilized nations, that before regarded each other with feelings of hatred and distrust, into relationships of amity and concord.

Men of science, learning, and position not unfrequently looked upon the humble champion of the railway as a lunatic, whose liberty was dangerous to society, and whose vagaries promised to overthrow the pillars of the State, unless the supposed madman and his ravings were placed under proper restraint. Even those whose confidence he possessed sometimes considered his ideas outrageous, and his theories absurd; yet the issue proved that the great engineer possessed too much shrewd common sense to risk the success of his scheme, by discovering at once all the capacity of that marvellous machine which owed its robustness and strength to his own patience and perceptivity.

George Stephenson was an Englishman of the truest and best type; whom difficulties could not daunt, whom the incredulous could not arrest, nor the callousness of professional conceit turn from his purpose. From that moment when the first conception of the wonderful capacity of the locomotive dawned upon his mind, he never lost faith in its ultimate success and universal adoption. Although of middle age when his services were first sought by the capitalist and projector, he lived to find his most ardent wishes gratified, and himself acknowledged as one of the greatest benefactors to mankind of his own or any time. The secret of his remarkable power and influence was well described by Stephenson while addressing a meeting at the

Leeds Mechanics' Institute on the occasion of his last public appearance. He said:—"I stand before you as a humble mechanic. I have risen from a lower standing than the meanest person here, and all that I have been enabled to accomplish in the course of my life has been done through *perseverance.*"



ROBERT STEPHENSON.

CHAPTER I.

ROBERT STEPHENSON'S EDUCATION.

HAVING endeavoured to trace in outline the public career of George Stephenson, we have now to deal with that portion of his private life which exerted a powerful influence over the fortune and fame of his distinguished son. Ere he had completed his third year, as we have seen, Robert Stephenson was deprived of his mother's loving solicitude. The place of her who had been so early called away from watching over his childhood was at first filled by strangers. His father was fortunate in the selection of his first hired housekeeper. She was an estimable woman, and attended to her young charge with scrupulous exactitude until her marriage with the child's uncle Robert, during the sojourn in Scotland of the master of the household, caused her situation to be occupied by another. The colliery-brakesman was not so happy in his second choice of a housekeeper. Upon his return from Montrose, and learning the fact of his brother's nuptials, George removed his son from the care of his sister-in-law, and again resided in the cottage at West Moor, which he had found closed on his arrival from the North. The person he then engaged to look after his domestic interests proved incapable of worthily

discharging her duties, and he wisely determined to ask one of his sisters to become for a time the mistress of his fireside and the warden of his son.

Eleanor Stephenson was nearly three years younger than her brother George, but an acute sorrow had given a staidness to her habits and demeanour not usually observable in one so deficient in age and experience. Jilted by a faithless lover on the eve almost of her expected wedding, a cloud had fallen upon the fair promise of her happiness, and the invitation to assume the position of a matron was willingly accepted by her, but rather from the desire to be useful to bereaved relatives than from a wish to secure to herself a home and shelter from the blast of adversity.

The kind and gentle disposition of "aunt Nelly" soon attracted the notice of the child, and caused him to reciprocate the tenderness and love which she manifested towards him. It is true that her strong religious sympathies sometimes evoked, as years passed on, the mischievous propensities of young Robert; but the fun at his good aunt's expense, in which he occasionally indulged, was more to be attributed to the exuberance of boyish feeling than to any inherent want of reverence in the boy for things sacred and proper.

Thomas Rutter, the village schoolmaster of Long Benton, and the first preceptor to him whose life now engages our attention, was fairly successful as a teacher, and at least one person of eminence besides Robert Stephenson was indebted to "Tommy" for the first rudiments of learning. But Dr. Addison, who attained distinction as a physician, and the younger Stephenson, whose gigantic bridges stand as monuments to his memory, would in all probability never have been thought worthy of notice by the biographer had their educational curriculum been confined to the sphere of the Long Benton school-house. When Robert was strong enough to perform the duty, he regularly carried the picks

of the Killingworth miners to and from the smithy at Benton. This commission he daily executed for a considerable time—taking the blunt implements with him on his way to school, and fetching the sharpened ones on his return. After some six years had been spent under Rutter's tuition, Robert was sent to Percy Street Academy, in Newcastle-upon-Tyne.

The physical constitution of his son not being sufficiently strong to stand the daily journey on foot between West Moor and the town, George Stephenson purchased a donkey, which the boy rode, with his satchel of books and aunt Nelly's homely provision for his refreshment slung over his shoulder. When he first entered the seminary of the Newcastle mentor—whose son, Dr. John Collingwood Bruce, the historian of the Roman Wall, now fills the honourable position of Moderator to the Presbyterian Church of England—Robert was in his twelfth year. A shy, country boy, without polish, his strong Northumbrian accent excited the risibility even of lads whose footsteps had scarcely ever passed beyond the boundary of his native county. In course of time, as his reserve wore off by daily contact and familiarity with his schoolfellows, his diligence as a scholar earned for him a good reputation in the eyes of his master, who not unusually upheld the spare, delicate scion of the Killingworth enginewright as an example of steadiness and application to such of his fellow-scholars as were wild or neglectful. Under the care of Mr. Bruce, Robert made considerable progress, although it cannot be said that his school-days were marked by any striking evidences of that mathematical genius which was to render him a prominent figure among the Englishmen who have become famous on account of their constructive abilities. When his name had become as a household word throughout Britain, Robert Stephenson alluded to his attendance at the Percy Street school, in a letter to Dr. Bruce, in the following sentence:—

"It was to Mr. Bruce's tuition and methods of modelling the mind that I attribute much of my success as an engineer; for it was from him that I derived my taste for mathematical pursuits, and the facility I possess of applying this kind of knowledge to practical purposes, and modifying it according to circumstances."

Shortly after Robert became a pupil under Mr. Bruce, he was often called to assist his father in prosecuting experiments, having for their object the construction of a mining safety-lamp. These experiments, simple as they undoubtedly were from a scientific point of view, were of advantage to young Stephenson in giving him a practical illustration of a principle which guided him throughout his brilliant career—namely, that whatever is worthy of attainment deserves an earnest effort for its accomplishment. The success that crowned his father's disinterested endeavours to mitigate the peril of a miner's employment stimulated Robert in after-life to make the safety of his workmen, when engaged in hazardous situations, a matter which demanded his peculiar and personal attention.

The defective knowledge which had hampered his own endeavours to rise in the social scale, George Stephenson desired to see removed out of the way of his son's elevation above his class. With that view he exercised a watchful supervision over Robert's studies at home. Not that the parent could render much assistance to the boy; for Robert, when in his thirteenth year, was far a-head of his father in the pathway of learning; but George looked upon the school-fees which he was called upon to pay for his son's education as so much capital invested, from which an adequate return could not be expected unless the lessons of the day were followed by the self-application of the scholar at night. Nor were Robert's reading and exercises confined to the routine of his tasks for the school, for he frequently spent some of his spare hours at the rooms of the Literary

and Philosophical Society of Newcastle, where he read works that would otherwise have been beyond the means of his father to obtain, and which were then considered as too valuable for ordinary circulation. On his return from these visits to the library, Robert was invariably catechised by his father in regard to the subjects which had claimed his attention in the course of his reading; and this practice, while it served as a mental training for the boy, enabled the colliery enginewright to become acquainted with facts in natural and mechanical science to which he might, without such help, have remained a stranger.

George Stephenson's neighbours considered him an unusually strict father in keeping his son so closely at work over books; but he swerved not from his purpose, which was to qualify the youth to become an engineer and the director of labour, rather than one who would be compelled to earn a livelihood by the sweat of his brow. In the course which he adopted, it is true that the elder Stephenson had no elevated opinion regarding the value of learning. He simply looked upon education as a means of furthering his desires: as an indispensable requisite to him who would be more than ordinarily successful in the world; and that was the extent of his ambitious plans for his son's benefit. So he continued, with the most rigid exactitude, to see that Robert not only prepared his allotted exercises for the school, but that he also extended his studies by pondering over the various treatises on philosophy, science, and art which the boy, as a member of the Literary and Philosophical Society of the northern metropolis, read at that institution, or brought home for the joint improvement of himself and his father. The drawings of plans and modelling of machinery also formed prominent features in the training which Robert underwent by his father's direction, and in after-life the son confessed, with filial gratitude and pride, that to the discipline and instruction received under the parental roof-tree

at West Moor was to be attributed much of that success and eminence which he had attained as an engineer.

The perseverance and industry that were so remarkably displayed in the every-day demeanour of his parent were not without their fruit in moulding the character of Robert Stephenson. Naturally of a bright and happy disposition, full of animal spirits, and prone to indulge in mischief when not under the spell of his father's watchful attention, in all probability he would never have become fitted for taking a more than ordinary position among his fellows, but for the training to which his father subjected him in boyhood, and the daily example which his father set before him of patient, never-tiring tenaciousness to self-imposed duty. Robert loved his parent with more than a son's devotion, and to give pleasure to him formed an estimable and marked line in the lad's conduct and bearing. To his filial affection, therefore, more than to any inherent liking for study and knowledge, may be ascribed his application as a scholar, and the acquirement of that information which was most calculated to further his advancement in life.

Notwithstanding the assiduity which distinguished Robert's pursuit of knowledge during the latter portion of his school-days, he occasionally found time for indulging his love of frolic, and even turned his acquaintance with natural science to account in the pranks played by him upon the property of the neighbours. Having purchased about half a mile of copper wire, and insulated it by means of a few feet of silk cord, he attached that conductor of electricity to a kite which he had made for the purpose of an experiment. While his kite was flying, nothing gave him greater pleasure than to communicate an electric shock to a farmer's cow, or to his father's pony, by the aid of his scientific toy; and although his father scolded him for the tricks perpetrated upon the favourite animal that carried its master on his journeys of inspection to the various collieries which he had

periodically to visit, George Stephenson felt inward satisfaction at the thought that his son was able to make a practical application of a theory which had attracted the lad's attention in the course of his reading.

A sun-dial, bearing the date "August 11th, MDCCCXVI," still stands over the doorway of the cottage where the Stephensons resided at West Moor, as a small but interesting monument of the patience and study of former occupants of the humble dwelling. The story of its construction, as told by Robert Stephenson himself, is given in Samuel Smiles' *Lives of the Engineers.* It was during vacation-time that the idea occurred to George Stephenson that the holidays of his son might be turned to some beneficial account by such an employment of his energies, and the successful accomplishment of the task gave satisfaction and pleasure both to the father and son, and formed a theme for much speculation and inquiry by the simple-minded colliers and their families. "I expostulated with him at first," said Robert, "that I had not learnt sufficient astronomy and mathematics to enable me to make the necessary calculations. But he would have no denial. 'The thing is to be done,' said he, 'so just set about it at once.' Well, we got a *Ferguson's Astronomy*, and studied the subject together. Many a sore head I had while making the necessary calculations to adapt the dial to the latitude of Killingworth. But at length it was fairly drawn out on paper, and then my father got a stone, and we hewed, and carved, and polished it, until we made a very respectable dial of it; and there it is, you see, still quietly numbering the hours when the sun is shining. I assure you not a little was thought of that piece of work by the pitmen when it was put up, and began to tell its tale of time."

About the year 1818 Robert's aunt, Eleanor, whose love and attention had been to her nephew like those of a mother, resigned her position as mistress of her brother's

household, for the purpose of fulfilling the more onerous duties of a wife to one of the colliery workmen, and George Stephenson had again to decide the important question as to the choice of a housekeeper. His former experience in that respect, immediately previous to the accession of his sister to the office, caused him to dread the recurrence of such an unfortunate contingency, and he wisely resolved, therefore, to enter for the second time into an engagement matrimonial. A somewhat romantic story has been published, in which it is given out that the second Mrs. Stephenson —Elizabeth Hindmarsh, daughter of a farmer at Black Callerton—was really the first love of her husband. The narrative states that on the attachment of the lovers becoming known to the young woman's father, George, then only a poor brakesman, was ruthlessly driven by the enraged farmer from his door. Elizabeth, we are told, immediately vowed that she would never have a husband other than George Stephenson; which resolution she religiously kept until her constancy was rewarded by an offer of marriage from the well-to-do colliery enginewright. That version of the affair is purely fictitious, apart from the inconsistency which would be involved in the thought of a young widower dooming the choice of his youth to celibacy for fourteen years. It was not until about the year 1819 that George was introduced to her who became his second wife, and that through the solicited instrumentality of Elizabeth's brother, Thomas Hindmarsh. The marriage, which was solemnised in Newburn Church on the 29th of March 1820, proved in every respect a happy one; for not only did Mrs. Stephenson lighten the burden of her husband's life by her affectionate concern for his interests, but the comfort and success of her stepson also gave occasion for the exercise of her studious regard.

Robert Stephenson left school in the year 1819, and was apprenticed to Mr. Nicholas Wood in order to learn the

duties of a colliery viewer, to which profession it was then intended by his father the future of young Robert should be devoted. Events connected with the development of the railway system afterwards conspired to alter the resolution which had thus been formed; but the instruction which he received under the distinguished mining engineer, whose name is worthily associated with the infancy and progression of railway enterprise, proved of incalculable benefit to Robert in the arduous undertakings which he was frequently called upon to accomplish in the course of his career. For nearly three years he was thus employed, and his daily work during that time formed on the whole a suitable preparation and training for the elevated position which he subsequently filled, with so much honour to himself and advantage to the world.

As a viewer's apprentice his demeanour was modest and unassuming: his conduct resolute and exemplary. The example of steady perseverance and devotion to the demands of his daily employment, which had been, and which continued to be, so conspicuously displayed by the parent whom he ardently loved and reverenced, formed a model to which his thoughts were frequently directed and his actions were invariably shaped. To gain at all times the commendation of his father was an object for which he strove with all the energy of his youth, and the eventual and complete fulfilment of that filial desire, when he had attained the estate of manhood, and had won for himself considerable prominence as an engineer, gave Robert Stephenson infinitely more pleasure than any he derived from the patronage and esteem of influential or exalted personages. Gradually the relationship of parent and son had merged into a close and intimate friendship which was fraught with much advantage to both. The period of life that generally finds young men seeking the companionship of their equals in age and lack of experience in the world's ways, found Robert spending

his evenings by his father's side in the cottage at West Moor, engaged in animated discussion over mechanical and engineering problems which both were essaying to solve, or suggesting alterations in locomotive construction, with a view to render the travelling engine still more serviceable, by removing defects that militated against its more extended and general adoption.

The application which young Stephenson had devoted to his studies while at school, and to his duties as an apprentice viewer, had developed, it was feared, a tendency to weakness in the respiratory organs which might culminate in confirmed disease, if prompt measures were not taken to alter the conditions of his employment by a radical change of its nature and scene. The appointment of his father as surveyor of the route of the Stockton and Darlington Railway, in 1821, gave an opportunity for releasing Robert for a time from his underground functions and the routine of the colliery office; and by permission of his master he assisted in surveying the ground for the proposed line. The outdoor exercise in which he then engaged, in company with John Dixon, and under his father's direction, proved of great physical benefit to him, while it allowed him still to put to practical use the instruction he had received from his schoolmaster in Newcastle, and from Mr. Wood at Killingworth. Making holiday of their work, George Stephenson, Robert, and Dixon took pleasure in their toil: camping during meal-hours in the fields by day, and taking up their quarters in homely old-fashioned inns by night. Seated in the tap-room or kitchen of a roadside hostelry, George took counsel with his assistant and his son each evening as to the features and incidents of the survey; gave instructions in regard to the task of the morrow; and generally before retiring either admonished the budding engineers as to their course in life, or drew animating and hopeful pictures of the future triumph of the locomotive and the railway. On the

completion of the survey the name and designation, "Robert Stephenson, engineer," was placed on the map of the route in deference to the wish of his father, whose desire thus to confer a mark of distinction in a humble way upon his son proved that his own personal ambition was eclipsed by the fulness of his parental affection.

Robert was now in his nineteenth year, and had become an enthusiastic believer in his father's theory that the universal extension of the railway system was only a question of time and money. His native shrewdness enabled George Stephenson to discover, in the success of his favourite project, a sphere wherein the energy and talents of his son might be employed with greater advantage to the latter than any to be looked for through following the profession of a colliery viewer. The brilliant prospect which railway engineering held out to those who would make its duties and responsibilities their study and care, forced him to the conclusion that the time had now arrived for Robert to extend, in a university city, his acquaintance with science and philosophy, in order to be fitted for assuming the position of a leader in the great enterprise which was to better the circumstances and conditions of life. Accordingly, and with Mr. Wood's consent, Robert was taken from the duties of an under-viewer at Killingworth and sent to the University of Edinburgh, which he entered as a student in October 1822. In forming the decision which led to that important step, George Stephenson had found his own opinion regarding the value of technical training as an aid to his son's advancement to be largely shared by gentlemen connected with the Stockton and Darlington Railway, who had noticed the intellectual capacity and energy of the young man while the latter was employed as an assistant in surveying the line.

During his stay of six months in the Scottish capital, Robert made the most of the limited term allotted to him

for mental improvement. He attended the Chemical Lectures given by Dr. Hope, and devoted several evenings during each week to Practical Chemistry, under the direction of Dr. John Murray. He also studied Natural History and Natural Philosophy in the respective class-rooms of Professors Jamieson and Leslie. His verbatim short-hand notes of each day's lectures were carefully copied by the assiduous student before retiring to rest at night. In following this practice he had not only in view his own progress in knowledge, but he earnestly hoped that his father might also profit by the course of university study, limited though it was, which parental forethought had devised for him. On his return to Killingworth, Robert's manuscripts of lectures which he had heard in Edinburgh formed subject-matter for mutual contemplation and discussion between the devoted father and son, and in after years the latter prized not the least of all the works in his library that set of volumes which contained the evidences of his own zeal and industry while at Edinburgh. Another reminiscence of his visit to the Modern Athens was found in the life-long friendship which he there formed for George Parker Bidder, who also became a distinguished civil engineer, and president of his professional Institute. Mr. Bidder had already been two years at the college when Robert Stephenson entered it for the first time, and during the stay of the latter the two friends were almost inseparable companions. As time wore on, and both were called upon to engage in successive Parliamentary struggles, they were invariably found side by side, as when class-mates at the University.

Returning from Edinburgh in the summer of 1823, Robert rejoined his father, who had been appointed engineer of the Stockton and Darlington Railway, and assisted him in various ways in that and other professional undertakings until the establishment of the Engine Works in Forth

Street, Newcastle-upon-Tyne, opened out another and congenial sphere for the exercise of the young engineer's talents and ability. As we have seen, his short college term had been distinguished by close application to his studies, and his health had suffered in consequence. His rapid growth, as he neared the threshold of manhood, had also impaired his physical strength, and excited his father's fear that he had inherited from his mother a constitutional tendency of a phthisical character. Ere the enervating symptoms had assumed a graver form, however, an opportunity was given to Robert Stephenson of breathing the beneficent air of a southern latitude, and of completing his education for the great work that lay before him, by the cultivation of self-reliance in the hour of difficulty, and a practical acquaintance with the anxieties inherent to the control and direction of labour.

CHAPTER II.

SANTA ANNA.

IN the year 1824 speculative enterprise was considerably stimulated by the dazzling prospects held out by the various companies that had been formed for the purpose of winning gold and silver harvests in the mines of South America. In the prosecution of those schemes much embarrassment was occasioned by the scarcity which then existed of professional men capable of directing such operations on the spot; and the services of young mining engineers, of even the slightest experience, were in great request for the development of projects which offered the most tempting inducements to those who had the requisite capital, energy, or ability to employ in that way. The Columbian Mining Association was established for the purpose of working certain gold and silver mines in Spanish America, which, it was assumed, had formerly yielded great profits to their owners, and only required British capital and industry to render them unusually productive of the precious metals. The mines of La Manta and Santa Anna were the most important of those for which leases had been obtained by the Association, and situated about twelve miles from Mariquita, a fine old city, deserted almost and decayed, but still noble amidst its

own desolation. Adjacent to these mines stood the small village of Santa Anna. George Stephenson was consulted by the directors as to the selection of miners, artizans, inspectors, and implements for the operations. He was also required to make on behalf of the company shipments of iron and merchandise for America. As his father's managing assistant, Robert was brought into prominence in the various commissions which were executed for the company; and the capacity and energy of the young engineer created favourable impressions in the minds of the projectors; so much so, that overtures were made from an influential quarter to the end that Robert might be induced to accompany the expedition as its engineer-in-chief, and the managing representative of the Association.

As manager of the Forth Street Works Robert Stephenson had displayed great ability. It was an onerous position for one so young to fill, but his industry, perseverance, and tact had enabled him to overcome many hindrances and entanglements which arose in the establishment of an entirely new species of British manufacture. His presence in Newcastle had almost come to be a necessity for the success of the venture, if any demand appeared for the motive power which the engine works had been mainly created to supply. But the Locomotive had not yet emerged from the cloud of popular prejudice and doubt which enveloped it, and the immediate future held out no favourable indications which could enable the Stephensons to discern the good fortune that was so soon to crown their hopes, their patience, and their enterprise. Under such circumstances at home, the gold and silver mines of the new world exerted a fascinating influence over Robert, and he earnestly entreated to be allowed by his father to accept the offered post for a period of three years. At first George Stephenson strenuously opposed the idea of even a temporary separation from his son; but eminent medical skill having been consulted in

regard to the possible effect which a residence abroad might produce in Robert's constitution, and the advice given by the doctor being unquestionably in favour of the change of climate, George was reluctantly obliged to yield his consent to the scheme, and Robert sailed from Liverpool on the 18th of June 1824, after an affectionate leave-taking with his father.

After a pleasant voyage during thirty-five days he landed at the port of La Guayra, on the north coast of Venezuela, and made a short stay, which he employed in reporting to the company upon a breakwater or pier for the harbour. He then proceeded to Caraccas, the capital of the district and about fifteen miles inland, where he remained for two months, as he was unable at that time to prosecute his journey further into the interior on account of the miserable state of the roads. He took occasional excursions in the vicinity of his halting-place, however, in order to discover the mineralogical condition of the neighbourhood, and its adaptability for mining operations. Early in October he started for Bogota, distant twelve hundred miles from Caraccas. The route to the capital of Columbia, or New Granada, lay through a most difficult region—the natural impediments on the road being rendered still more perilous by the bands of lawless ruffians who infested the country for the purpose of despoiling the unwary traveller. Mounted upon a mule and well armed, he travelled slowly, carefully noting on the way the characteristics of the ground over which he passed. He was accompanied by the interpreter to the expedition and a black servant. A guide was also employed on the journey to point out to the engineer various mining stations which, according to popular tradition or the inventive genius of the guide himself, had formerly yielded rich returns to the fortunate discoverers of the metallic hoards of mother earth in that region.

Robert Stephenson's first mule journey in South America

gave him the liveliest satisfaction and pleasure. The animal he rode, the costumes and manners of the people among whom he travelled, the luxurious beauty of the tropical vegetation, his own picturesque habiliments, the net-hammock in which he was frequently suspended from the branches of trees at night, the salubrity of the atmosphere, and the dazzling grandeur of the scenery around him, all tended to interest and gratify his senses alike by their novelty and character. His undersuit of white cotton, partially covered by a "ruana," or cloak of blue and crimson woollen stuff, which also served the purpose of a blanket as he lay in his hammock at night, and his high-crowned hat of plaited grass, surrounded by a wide brim which sheltered his face and neck from the scorching rays, gave to his appearance features more in keeping with the fabulous ideal of some hero of romantic adventure than the simple habits of a son of homely Northumbria bent upon a mission of peaceful enterprise. But it was necessary to attract as little attention as possible to the geological observations which he was commissioned to make upon his journey, and he adopted the "ruana" of the masculine inhabitants more for the safeguard which the showy attire afforded to the wearer against the prying curiosity of the people towards all foreigners and their actions than for the gratification of any personal love of gaudiness or display.

Arrived at length at his destination, the engineer selected at first, as the scene of his operations, two long-abandoned mines, which had been formerly worked by their Spanish owners. These old workings were respectively named La Manta and Santa Anna, and had become lost in the density of the vegetation that covered them. But Robert's habitual energy was soon at work in opening out the neglected adits, and the services of native peons were called into requisition to prepare the mines for the trained labour of a band of Cornish miners, then on the way from England. The rank

growth of years had to be removed, roads cut to the workings, ground excavated, and machinery erected. In prosecuting his duties the younger Stephenson had many difficulties to surmount, not the least of which arose from the laziness and duplicity of the peons whom he had engaged for the preliminary work of laying bare the openings to the mines. Whenever the eye of the manager was called away from their immediate vicinity a number of the gang would desert, and leave the master of the ceremonies to employ such devices as fortune might suggest for the purpose of filling up the vacancies which an inherent love of idleness had created in his gang of labourers. Other fruitful sources of disappointment and annoyance to the engineer lay in the inertness of the authorities and the counter-schemes of rival mining companies, whose agents were endeavouring to blight the interests of the Columbian Association in influential quarters. But Robert's tact and determination enabled him to cope successfully at least with the machinations of his rivals, while he anxiously longed for a period to be put to the enforced delays which idleness occasioned to his plans by the arrival of the hardy Cornishmen, who would prove, he doubted not, worthy representatives of his country's working classes. The hope of getting from his countrymen a fair day's return for a fair day's pay, however, was doomed to be unrequited.

When the miners arrived from England, Robert Stephenson found a totally different description of their class from that with which his childhood and youth had been spent in Northumberland. The men were, as a rule, dissolute and drunken: without personal restraint, and that respectful bearing towards those placed over them, without which there cannot be anything like a wholesome discipline, or that mutual confidence which should characterise the relations between bodies of workmen and their employers or overseers. To add to the perplexity of the engineer's

situation, a large portion of the machinery, which had been forwarded to him from England, proved too cumbersome for transit over the rough and undulating roads between the port of debarkation and Santa Anna. He had therefore to make shift with the lighter machinery and implements, and to order from home other machines which experience had taught him would be more suitable for conveyance, and more adapted for the work to be performed. By the end of October 1825, a sufficient number of men had been brought from England to enable him to carry on the operations with some degree of success, had he been but adequately supported by the efforts of his men. The latter, however, had been engaged upon terms exorbitantly high, and their prosperity proved a stumbling-block and a curse to them, rather than a means of raising them in the social scale when their term of engagement had been concluded, and they had returned again to their mother country. An occurrence in his South American experience illustrates the qualities which Robert Stephenson possessed of bravery, self-reliance, and aptitude for dealing successfully, and without hesitancy, with the impediments incident to his profession.

The extremely youthful appearance of their chief had not prepossessed the Cornish miners in his favour. Besides, his Northumbrian accent, and his reputed connection with coal pits and engines, rendered him in the minds of his stubborn countrymen wholly unfitted to direct the labour of men trained from their childhood in the process of metalliferous mining. Consequently they treated his commands frequently with indifference, and sometimes with contempt; while his occasional remonstrances in regard to their lazy and debauched excesses aroused the demon of mutiny within them, and brought them into open and declared rebellion against the authority of the engineer. Their daily resentment and hostility culminated in an organised attempt to overawe him by an exhibition of reckless and riotous force. The

Cornishmen had not, however, calculated that the beardless "clerk," as they termed him among themselves, could be even more resolute and determined than a band of drunken mutineers. But happily for all concerned the event proved such to be the case. A rearrangement of the gangs of workmen at the several mines belonging to the company gave an opportunity for open and declared revolt.

Wearied with the work and anxieties of an unusually arduous day, Robert Stephenson had retired to rest in his room at Santa Anna, when he was awakened from his slumber by the vociferous yells of the miners, who, in a dissolute rage, surrounded the doorway and windows of the cottage where he had his home; while some of the more daring spirits hesitated not to enter the room adjoining that in which their master lay fatigued, but conscious of the desperate character of his visitors. The infuriated rioters roared out at intervals their resolution to throw off the yoke of a smooth-faced youth, while the subject of their anger lay on his couch for upwards of an hour listening to the threats and imprecations of the leaders in the tumult. He was aware that their words of insolence and menace were intended to reach his ears, but he dreaded the consequences of a personal collision with the rabble, more for the sake of the miners themselves than on account of any fear which he entertained that his own safety and life were in jeopardy. At length the leaders grew bolder in their utterances, and avowed that the "clerk" ought to be taught to keep his proper place; which, according to their views, consisted in his procuring the requisite sums for the stated payment of their wages. Robert had controlled his rising passion, and had trusted that his own quietude in the face of their insolent taunts would have the effect of subduing the fire of their hostility, and of suggesting to their leaders a withdrawal of the inebriate madmen from the vicinity of his sleeping apartment. Such a peaceable conclusion to the

demonstration never occurred, however, to those by whom it had been proposed or organised, and Robert, fearing that his continued silence might be construed to result from effeminate cowardice, resolved to brave the storm which his self-control and passiveness had proved unfitted to allay. Rising from his bed, therefore, he made his way into the midst of the miners, alone and unarmed, but with a coolness and dignity of demeanour that struck the Cornishmen speechless with astonishment at the daring nature of the action.

Quietly taking a position in the centre of the room in which the leaders had ensconced themselves, the engineer stood erect, and calmly looked at the mutinous band before him. Not a sound from the formerly bellicose lips broke the intense stillness that so suddenly reigned in the apartment. Noting the effect of his presence upon the men, Robert said in a deliberate and firm tone, "It won't do for us to fight now. It would not be fair on my part; for you are drunk, while I am sober. We had better wait until to-morrow. The best thing you can all do is to break up your meeting and go quietly away."

Without hazarding a reply, the men slunk out of the cottage, which they surrounded, with muttered threats of vengeance towards him who had cowed them into a temporary submission to his will by coolness and self-possession. But, removed from the presence of their superior, the scoundrels had again recourse to an abuse of their vocal powers, by shouting as loudly as before. That they continued to do for two or three hours, while the object of their hatred and awe calmly smoked a cigar, and allowed them to witness the apparent unconcern which his indulgence in the fragrant weed under such circumstances was calculated forcibly to suggest.

Robert Stephenson's life had been spent among miners, and he had, as a viewer's apprentice, been accustomed to deal with them in matters pertaining to their vocation in a

kindly and generous spirit. He now found himself, however, face to face with a difficulty from which men of greater age and experience than his own might have recoiled in distrust and aversion. Before leaving England he had visited some of the principal mines in Cornwall; a fact of which the workmen now under his charge were fully aware. But they knew also that the young engineer was not a native of their county, and he was obnoxious to them as well on this account as because of the impression, to which Cornish miners in those days tenaciously clung, that North-countrymen possessed but a superficial knowledge of the science and practice of mining. Cognizant of that prejudice, and the bitterness of the animosity which had prompted a demonstration in force against his authority, Robert took steps to ensure respect to his position in the first place, and then to lead the men to a better state of feeling and conduct by setting before them inducements to rational amusement, and his own example in following healthful recreation. A renewal of the riot a night or two after the first ebullition of drunken rage and excitement caused him at once to ask for an emphatic declaration from the Board of Directors in London as to his relation to the employées of the company. Without unnecessary delay a missive arrived asserting the engineer's right to demand prompt obedience from all engaged at the mines. His position as chief of the expedition having been thus authoritatively defined, he endeavoured to secure the establishment of a kindlier feeling on the part of the miners towards himself. This he effected to a considerable extent by encouraging the men to spend their evenings in athletic sports and feats of dexterity. By displaying his own accomplishments in these he gradually gained the respect of the miners, and instead of engaging in mutiny against him, the Cornishmen found a more pleasurable kind of opposition to their manager by striving to excel him in the cast-

ing of quoits, the raising of heavy weights, and the throwing of a hammer.

But the management of his workmen offered but one of the embarrassments which Robert Stephenson was called upon to encounter during his connection with the Columbian Mining Association. Another and a greater difficulty was soon to be experienced in the character of the undertaking of which he was the practical head. Ere he had completed the first year of his engagement the unsoundness of the scheme was only too apparent to him, and that not only from his experience at the mines, but also from the opinions of gentlemen in England whose professional position gave them the right to be considered as good judges in such matters. In short, the conviction was irresistibly forced upon him that the enterprise was but one of the many chimerical speculations which have saddened the lives of English investors. He was satisfied that no credit would accrue to himself through his relationship to the company, and he might have brought his stay in the new world to a premature close, but for the thought that he was bound in honour to fulfil the term which had been stipulated as the limit of his absence from his native country. He accordingly redoubled his efforts to achieve for his employers that success which their own mismanagement in London neither warranted nor deserved.

By utilising time and opportunity to the utmost, he accomplished a large amount of hard and important work. All his powers were devoted to the almost hopeless task of earning and saving money for the company. The country far and near was explored by him. Specimens of ore were collected and assayed by his hands. He sketched out a plan for the effectual direction of mining operations. His letters and reports were voluminous and to the point. All his labours, however, met with no adequate response from the directorate in London. His urgent requests for light

and suitable machinery, easy of transport and convenient for the operations of the engineer when delivered at the mines, were met by the despatch of unwieldy and costly apparatus, ill-adapted alike for transmission over the rough and acclivous roads of the country and the purpose for which it had been constructed. His chagrin and disappointment were frequently augmented by the inconsiderate demands of a section of his directors for more tangible results than the young engineer, with all his energy, application, and toil had been able to produce. Truly an irksome situation for a young man of twenty-two: a situation that would have crushed the spirit and broken the heart of many less zealous, upright, and resolute than Robert Stephenson. But the time which he spent among the old mines of the Andes formed a period in his educational and professional training that qualified him to grapple successfully with sterner perplexities and more momentous undertakings.

When the hour arrived when he might honourably leave the service of the company, the engineer represented to the directors the advisability of appointing his successor. Letters which he had received from his father, and other partners in the engine factory at Newcastle, told him of the gloominess of the outlook for those who had invested their capital and talents in the concern, unless a turn in the tide of its affairs occurred to give increased vigour to its existence, and renewed hope to its proprietors. Robert Stephenson felt, therefore, that his presence in England at such a juncture was not only required for his own sake, but that it had become a matter of paramount importance that he should again resume the management of the works which his Columbian engagement had compelled him to resign. An urgent request from the board in London that he would retain his post at the mines for a time after the termination of his engagement was rejected respectfully, but firmly; and he proceeded to make arrangements for leaving a situation

which had proved to him a continual source of anxiety, drudgery, and falsified hopes.

Quitting Santa Anna, he made his way to Carthagena, where he expected to find a vessel about to start for England. In that, however, he was disappointed; but a ship being nearly ready to sail for New York he therein took a passage for that port, intending thence to proceed to Liverpool or London. Trevithick, of locomotive celebrity, worn-out, gaunt, and weary with the buffeting of adverse fortune, had just arrived at the town of Carthagena, after undergoing innumerable privations in his search for wealth and honours. The daring and original Cornish inventor was accidently met by Robert Stephenson at an inn, and Trevithick joined the party to which his countryman was attached, and also started for the United States. After an eventful voyage, marked by the perils of a hurricane and shipwreck, young Stephenson landed at New York, whence he travelled with his friends to Montreal, where he discarded his Columbian attire, and, donning again an English costume, appeared in the circle of the best society. Returning to New York he took a passage for Liverpool, where, on his arrival, he found his father comfortably settled and engaged in constructing the second public railway.

The sojourn of the engineer in South America proved of infinite value and benefit to him in several ways. It enabled him to cultivate self-reliance, by being thrown entirely upon his own resources in the hour of difficulty or danger. It gave him opportunities for enlarging his ideas by contact with strangers, and for prosecuting his studies in the higher branches of mathematics, and in various sections of natural science. In these endeavours after self-education he was aided by the friendship which he had formed in Columbia for Dr. Roullin, a mathematician of distinction, and for M. Boussingault, an accomplished chemist and geologist. Robert Stephenson's weeks of hard mental work were

occasionally relieved by excursions to neighbouring towns, where he was naturally attracted to the society of the few Englishmen resident therein; but they were persons of culture and refinement, and the acquaintanceships thus formed assisted in rubbing off much of that roughness in speech and manner which yet remained to show his descent from humble provincial parentage. The mildness of the atmosphere which surrounded his mountain-home in the Andes proved also beneficial, in that it conduced, in all probability, to the suppression of those phthisical symptoms which had caused some anxiety to his father before Robert sailed for the Columbian Republic. On his return to his native land as a bronzed and stalwart man in his twenty-fifth year, both his mental powers and physical frame appeared to have been strengthened and refreshed, in anticipation of that busy career that lay before him, and which was necessarily to make the most exacting demands upon his faculties of body and mind. Altogether, the experience which he gained during his residence in South America formed not the least important portion of Robert Stephenson's education.

CHAPTER III.

THE MECHANICAL ENGINEER.

ALTHOUGH care and anxiety had imprinted distinct lines on the countenance of the elder Stephenson, and had given to his hair a premature whiteness during the absence of his son, Robert found that the three years that had elapsed since their parting at Liverpool had not shaken the faith of his father in the ultimate national recognition of the superiority of the travelling engine over other motive agents in the inland conveyance of passengers and merchandise on a large scale. The Stockton and Darlington Railway had been worked for some time with satisfactory results; but its locomotives were rather regarded as experimental machines, to which some interest was attached on account of their novelty, than as the pioneers of a system that was worthy of universal adoption. Not till the line between Liverpool and Manchester was nearly completed did the real and earnest battle for the Locomotive begin. In 1826, as already noticed, power had been obtained to lay down that railroad, and the appointment of George Stephenson as the engineer thereof had been regarded, as well by his friends as by his enemies, as the harbinger of his ruin, and of his retirement to that humble

obscurity from which he had the temerity to emerge. The feeling of distrust with which his plans for the construction of the line was regarded in influential quarters was not diminished by the difficulties experienced in making a road over Chat Moss; but the patience and energy of the engineer had overcome the natural impediments to his success, and when Robert landed in England, after his residence in South America, he was able to congratulate his father, not only upon having surmounted the obstruction caused by the morass in question, but also upon having won the confidence and good opinion of the directors of the company regarding his professional genius and ability.

If the responsibilities of his position had so altered George Stephenson's looks as to cause him at the age of forty-six to assume the appearance of a man considerably more advanced in years, the interval of separation between the devoted father and son had changed the raw Northumbrian youth into a polished gentleman. Robert had profited by his travels and experiences in the new world. At a period of life when many young men are found to be giving more attention to questionable pleasures than to the active realities and claims of duty, the young engineer's arduous labours had only been relieved by further mental exertion, or by the scant hours devoted to repose. Intercourse with his superiors, as well as his situation as the manager of uncouth, untaught, and daring men, had not rendered him arrogant or supercilious; but had rather intensified the innate amiability of his disposition, and lent to his person and manners the additional charms of refinement and self-possession.

Having spent a few days in the society of his father at Liverpool, Robert went to London, where he had an interview with the directors of the Columbian Association, who, with expressions of their personal esteem for him, and thanks for his faithful devotion to the services of the company, pressed him to continue to counsel and advise them as to their future

mining operations. This visit to the metropolis was also marked by his entering into contracts for the firm of Robert Stephenson & Co., the indifferent management of which had mainly induced him to return to England. After a journey to Brussels, made in connection with the business of the factory, he once more set foot in Newcastle-upon-Tyne, where for the succeeding five years he continued, with unremitting assiduity, to devote his talents and industry in directing the efforts of his workmen, in originating or developing improvements in machinery for locomotive construction, and in the endeavour to raise the Locomotive itself out of the ruts of uncertainty and prejudice that had retarded its progress in popular favour and service.

The year 1828 brought with it to Robert Stephenson increased, but on the whole pleasurable, responsibility. When he took up his residence in Newcastle, the prospects of the Locomotive were anything but encouraging to the proprietors of the factory, which had been established in anticipation of a demand being created for the "iron-horse." The slow rate of speed to which the Killingworth and Darlington engines were confined was not calculated to excite enthusiasm in their favour. But these had not been built with the object of attaining a swift convenience for passengers, but solely for the purpose of ensuring an economical transit for coals or merchandise; and the task that the Stephensons had to perform was that of improving the construction and capacity of the travelling engine, so as to render it suitable for adoption by the directors of the Liverpool and Manchester Railway, whenever the question of haulage on that line came to be seriously considered. The following extract from a letter written by the younger Stephenson to his friend, Mr. Longridge, who was also connected with the works at Forth Street, shows that the writer was anxiously concerned about the future of the locomotive. The communication was penned from Liverpool on New Year's Day 1828. Robert

had been spending a few days with his father, whom he had accompanied over a portion of the railway then being constructed between the great port on the west coast and the cotton capital. "I have just returned," Robert says in his letter, "from a ride along the line for seven miles, in which distance I have not been a little surprised to find excavations of such magnitude. Since I came down from London, I have been talking a great deal to my father about endeavouring to reduce the size and ugliness of our travelling engines, by applying the engine either on the side of the boiler or beneath it entirely, somewhat similarly to Gurney's steam-coach. He has agreed to an alteration which, I think, will considerably reduce the quantity of machinery, as well as the liability to mismanagement. . . . It is very true that the locomotive engine, or any other kind of engine, may be shaken to pieces; but such accidents are in a great measure under the control of enginemen, who are, by-the-by, not the most manageable class of beings. They perhaps want improvement as much as the engines."

Locomotive improvement, before the construction of the "Rocket" and its victory at Rainhill in October 1829, had been carried on by a slow and costly process; for Stephenson's famous engine was built twenty-six years after Trevithick had constructed a tram-road locomotive for the Pen-y-darran Iron Works in South Wales. The travelling engine owed its existence at first to personal enterprise, for it was only after private capital had been expended upon the furtherance of efficiency in the machine that public companies offered their money for carrying out an object which individual effort and means had hitherto struggled unaided to attain. The hope that a serviceable engine would find a market and a purchaser had stimulated mechanical engineers to increase the outlay of their time and cash, and it was the prospect of an ultimate return for such an expenditure that urged the firm of Robert Stephen-

son & Co. to continue the search after improvements, until rewarded by a well-merited and complete success. In prosecuting experiments for that end, the industry, talents, and skill of the young engineering manager were conspicuously prominent.

The return of Robert Stephenson to England, and to his post as the practical chief of the engine factory at Newcastle, produced a twofold good effect, in that it gave to his father reliable assistance at a most critical moment, while it inspired the other proprietors of the works with confidence as to the future of their undertaking. Robert's presence in the factory also exerted a powerful and beneficial influence over the workmen. In every department of the establishment confidence in the manager, and respect for his authority, characterised the bearing and conduct of all employed. During his active personal connection with his men he was regarded by them with affection, and to win his approval was the study of their lives. In all his dealings with them a marked contrast was presented to the spirit which his presence had evoked among the miners of Santa Anna. Robert was proud of his Newcastle mechanics, and the feeling was on their part uniformly reciprocated. To that mutual esteem much of the early successes of the firm may be largely attributed; for a determination was thereby created to make the factory worthy of patronage by turning out superior machinery. That resolution actuated all concerned, from the manager down to the youngest apprentice.

In October 1828, the railway between Liverpool and Manchester was so far advanced as to force upon the attention of the directors the question of the motive power to be used in working the line; and a deputation from the Board visited the North for the purpose of seeing the Stephenson locomotives there at work, and reporting on the advisability of employing travelling engines on the western railroad. This journey to the neighbourhood of Newcastle and to

Darlington convinced the deputation that horse-power would not be suitable for the immense traffic that was anticipated for the Liverpool and Manchester Railway. Consequently the question had narrowed itself to the erection of stationary engines or the use of locomotives. The point to be decided was an important one, and the Board therefore felt justified in calling to its aid further professional skill, in order to assist in the solution of the problem. In January 1829, Mr. James Walker of Limehouse, and Mr. James U. Rastrick of Stourbridge, were asked to report on the relative advantages of the two systems of haulage. The engineers named accordingly paid a visit to the Stockton and Darlington Railway, where both descriptions of engines were at work for their inspection. They also saw the locomotives in the vicinity of Newcastle. On the 9th of March following, the separate reports of the engineers were handed to the directors, and the verdict of each was comparatively adverse to the claims of the Locomotive. The case could hardly have been otherwise, for the unwieldiness and tardy progression of the travelling engines then employed were not fitted to inspire admiration of their powers. But the iron-horse, in spite of its defects and ugliness, had staunch friends, who resolved to stand by it until the tide of public prejudice turned in its favour.

Robert Stephenson took exception to the reports of Messrs. Walker and Rastrick, although it must be conceded that the reputation of the engineers gave a guarantee for the conscientiousness with which they had discharged their duty in the matter. But the son of the Locomotive's stoutest advocate saw, in the opinions which had been presented to the directors of the line that his father was then constructing, a barrier raised not only to the adoption of the engine which the factory at Newcastle had been mainly started to construct, but to the further extension of the railway system in England. The younger Stephenson

felt that the obstacle could only be fairly surmounted by endeavouring to engraft improvements of an unquestionable character upon the Locomotive. He therefore redoubled his efforts to attain that object. With characteristic prudence he refrained from engaging in a mere war of words, and withheld for a time from issuing a counter-statement to the reports which had given so much disappointment to his father and to himself. It was not a crisis to be met by a perhaps acrimonious debate. Action, vigorous and decided, could alone cope with the gravity of the situation. In a letter to a friend, written two days after the receipt of the reports, Robert Stephenson said:—"Rely upon it, Locomotives shall not be cowardly given up. I will fight for them until the last. They are worthy of a conflict." In the contest that ensued the young engineer took a bravely prominent part. But the weapons he wielded were industry and skill, rather than diplomacy and hard speeches.

The memorable "Battle of the Locomotive" called for the exercise of much patience, determination, and energy on the part of those who led the attack on popular prejudice and pusillanimity. George Stephenson, as soon as he had mastered the more serious portion of his difficulties in constructing the Liverpool and Manchester Railway, never allowed an opportunity to pass without urging the claims and superiority of the travelling engine upon the directors of the line. The unfavourable reports of Messrs. Walker and Rastrick did not cool the ardour of the great engineer, nor cause him to abate the persistency which had characterised his representations to the Board as to the desirability of testing locomotive power in the transport of material during the further progress of the work. While the elder Stephenson was thus advocating the adoption of his favourite machine, the younger was earnestly employed in the endeavour to improve the Locomotive, and thereby place its value and advantages beyond the sphere of question or uncertainty.

The efforts of the famous father and son, to secure a victory for the forces which they commanded in the "battle," were so far rewarded by the concession of an order from the directors for an engine to assist in the operations, *en route*, of the engineer. A locomotive being sent, in terms of that order, from the Tyneside factory, and placed upon the finished section of the railroad, its utility not only justified the advice which had been given for its procurement, but proved conclusively that Robert Stephenson and his mechanics were working with a will to secure for Newcastle-upon-Tyne a prominent position and reputation, as the centre of a new and highly-promising branch of British industry.

In Mr. Henry Booth, the treasurer of the Liverpool and Manchester Railway, the Locomotive had also a staunch friend and enthusiastic advocate. Having an inherent taste for mechanical pursuits, he would in all probability have made a name for himself as an engineer had he followed that line of life as a profession, instead of indulging in its experiments as a pastime. To the close intimacy which subsisted between the amateur mechanic and George Stephenson, the Locomotive was indebted for one of its most important improvements. To increase the power and speed of the engine, Robert Stephenson had applied his energies upon assuming direction of the factory at Newcastle; and that desideratum the young manager had felt could not be attained until means had been devised by which a capability would be given to the Locomotive of generating steam with rapidity. The multitubular system, which enabled the heating surface in contact with the water in the boiler greatly to be extended, obviated the difficulty which had caused so much disappointment to the Stephensons, and conduced in no small degree to the victory of the "Rocket" at Rainhill.

We have already alluded, in our sketch of the career of

George Stephenson, to the circumstances under which the celebrated "Rocket" was constructed. As soon as the terms of the competition were published, Robert Stephenson took counsel with his father as to the model of the engine to which the fortunes of the firm of Robert Stephenson & Co. should be entrusted, when the hour for the trial arrived. Both father and son were fully persuaded that a crisis in the history of locomotive-building was at hand. Heavy engines of the Wylam and Killingworth types must soon give place to lighter and speedier ones; therefore, while Robert was racking his brain to devise means for obviating the cumbrous gearing of the Locomotive, the elder Stephenson was striving to obtain the extension of the heating surface in the boiler, so as to add the important quality of speed to that of lightness. While the Stephensons were thus engaged, Mr. Henry Booth was also studying the subject of locomotive improvement. He was fully aware of the difficulties to be overcome before the travelling engine could be made available for passenger traffic on a large scale, and in his frequent interviews with George Stephenson the topic of the approaching competition formed matter for question and discussion. At length the idea of the multitubular boiler dawned upon Mr. Booth's mind, and he at once communicated the plan to his friend. George Stephenson perceived, in the suggested alteration in the boiler, a solution of the problem which had given himself so much anxiety, and he lost no time in forwarding to his son a drawing and description of Mr. Booth's admirable contrivance, which was immediately adopted by the manager of the factory, and embodied in the "Rocket." The following explanation of the multitubular boiler, and the steam blast, taken from Tredgold's treatise on the Steam-Engine, may be of interest to non-professional readers:—

"By causing all the flame and heated air to pass through a great number of small tubes surrounded by the water, a very great and rapid

means of heating the water is obtained, as a very large heated surface is thus exposed to the water. The first locomotive engines had merely a large flue passing from the fireplace to the chimney. It was bent round at the end and returned again to the back, the chimney being placed at the same end as the fireplace. The fire was contained in the commencement of the flue, which was made larger for the purpose. This is the general principle of the construction of the boilers for stationary engines, where the size and weight of the boiler are not of so much importance, and the flues can be made large enough to get a sufficient area of heated surface in contact with the water. But as in a locomotive engine all the machinery has to be moved at a great velocity, the size and weight of the boiler are obliged to be diminished very much, and some other means has to be adopted to obtain the requisite heating surface.

"The 'Rocket' engine, made by Mr. Robert Stephenson, which was the engine that gained the prize for the best locomotive at the opening of the Liverpool and Manchester Railway in 1829, was the first engine made with tubes in this country.

"The former locomotives, with only a flue through the boiler, had never been able to travel faster than about eight miles an hour, as they had not sufficient heating surface in the boiler to generate steam for supplying the cylinders more rapidly; the speed attainable by a locomotive being limited only by the quantity of steam that can be generated in a given time. The introduction of tubes into the boiler is one of the greatest improvements that has been made in the construction of locomotives, and was the cause of the superiority of the 'Rocket' engine to those that competed with it, and to all former engines. The velocity it attained at the competition trial was twenty-nine miles an hour, and the average fourteen-and-a-quarter miles an hour.

"The tubes of the 'Rocket' engine were three inches in diameter, and only twenty-four in number. In the engines made subsequently the size was reduced, and the number of them doubled and trebled, by which means the heating surface was very much increased, and with it the power of the engine. The smaller the tubes are the greater is the heating surface obtained, as small circles have a much larger circumference in proportion to their area than large ones. But when the tubes are diminished in size the total area of passage through them from the fire-box to the chimney is also diminished; and consequently if the diameter of the tubes were much diminished the draught of the fire would be checked, from the passage to the chimney being too small. The heating power of the boiler would thus be injured, although

the amount of heating surface exposed to the water was increased, and the abstraction of the heat from the hot air more perfect. . . . The tubes open into the upper part of the smoke-box, and the hot air passes from them up the chimney. No smoke is produced, except at first lighting the fire, as the fuel used is coke, which does not cause any smoke in burning, but only a light dust. The height of the chimney is obliged to be small, as it can never exceed a fourteen feet height from the rails: so that the draught produced by it is not at all sufficient to urge the fire to the intense degree of ignition that is necessary to produce steam at the pressure and in the quantity that is required, and some other more powerful means has, therefore, to be adopted to produce the draught. This is done by making the waste steam issue through a pipe, called the blast-pipe, which is directed into the centre of the chimney, and is gradually contracted throughout its length, to make the steam rush out with more force. This pipe is made of copper one-eighth of an inch thick, and is three-and-three-quarter inches in diameter inside, at the bottom where it joins on to the cylinders, and tapers to two-and-a-half inches at the top.

"The waste steam rushes out of the pipe with great force up the chimney, carrying the air with it, and causing a very powerful draught through the tubes and the fire. A whole cylinder full of steam is let out at each stroke, and the two cylinders deliver their waste steam alternately; so that when the engine is running fast an almost constant current of steam in the chimney is produced, and the interval between the blasts can scarcely be perceived. By this method the fire is not blown, as is usual, by forcing air into it, but by extracting the air from the flues and drawing air through the fire. In the first locomotives no means were used for increasing the draught of the chimney, and their power of generating steam was consequently very limited. The introduction of the steam blast for urging the fire, and of the tubes for conveying the air through the water, are the principal causes of the great power of the present locomotives."

The "Rocket," when finished, was taken to Killingworth, and there placed upon the railway, in order that its fittings and powers might be thoroughly tested before the engine was forwarded to Liverpool. The steam was raised so rapidly, continuously, and in such volumes, as to cause the machine to appear quite a marvel of mechanical manipulation in the eyes of all who beheld its trial trip on the railway which had been associated with George Stephenson's

early engineering successes. The multitubular boiler, as well as the modifications in the driving gear which were introduced by Robert Stephenson for the purpose of giving lightness to the engine, proved eminently successful; so much so, that the builder of the "Rocket" was enabled to inform his father, by a letter written on the evening after the private and preliminary experiment, that the new locomotive was satisfactory in every respect, and would be in thorough trim on the day of competition. It was in due course shipped from the Tyne for Liverpool, where it arrived after an unusually rough passage and considerable delay. Indeed the vessel which carried the engine, on the safety of which so much depended, was so long after her time that the sum of £500, insured against the loss of the "Rocket" at sea, had been paid by the underwriters when the ship arrived at her destination with her interesting freight uninjured by the violence of the waves. On Tuesday, the 6th of October 1829, Robert Stephenson & Co.'s locomotive was the first of the four competitors to be ready to obey the orders of the judges at the celebrated tournament at Rainhill.

But the time and attention of the younger Stephenson had not wholly been devoted to engine-building since his arrival in England from South America. Early in 1828 we find him constructing machinery to be sent out to the mines of the Columbian Association; after which he gave personal assistance to his father, by superintending some of the operations on the Liverpool and Manchester road. Now he is at Runcorn, in Cheshire, deliberating on the expediency of making a tunnel under the river Mersey; then he is employed in surveying for a projected line to join the railways between Bolton and Leigh, Liverpool and Manchester; to be followed by another survey for a branch between the Liverpool and Manchester railroad and the town of Warrington. The latter was the first to be con-

structed under Robert Stephenson's direction as the engineer of a public railway. The following extract from a letter, which he wrote to a friend on the 27th August 1828, shows that his spare time, after the claims of the engine factory upon his care had been satisfied, was devoted to duties of an onerous and sometimes irksome character. The letter was dated from Liverpool, and the writer says:—

"I had prepared this morning to get my things packed up for going off to Newcastle to-morrow morning, but there was a meeting of the directors of a short line of railway which I have got the management of near Bolton. The plans and section had been previously laid before them with an estimate. To-day they came to a resolution that, although the line pointed out by the engineer was the best, they were alarmed at the expense of it, and in consequence ordered a fresh survey and section to be made, so as to reduce the expense, even at the risk of having a less advisable line. This is one way of doing things, but proud as I am I must submit. I have tried in my cool and solitary moments to look with patience on such proceedings, but . . . it requires a greater store than I have. I would patiently bear this alteration if they did it from principle; but knowing, and indeed hearing them say, from what the alteration does really spring, I cannot but consider it unworthy of Liverpool merchants. I plainly perceive a man can only be a man. As soon as ever he aspires to be anything else he becomes ridiculous."

Before starting for the Columbian mines, Robert Stephenson had made the acquaintance of a young lady whose engaging disposition and manners, rather than the beauty of her face or the elegance of her figure, had made a considerable impression upon his heart. Miss Fanny Sanderson was the daughter of a gentleman residing at Broad Street, in the city of London, and if the young engineer had not already pledged himself to proceed to Mariquita, his introduction to Miss Sanderson might have turned the current of his thoughts in another direction than that of searching for gold or silver in the land of the West. When the offer had been made to him of the engineership of the Columbian Association, both his father and his stepmother had en-

deavoured to dissuade Robert from accepting the post, and had held out to him the advantages of an early marriage and settlement in his own country as counter-attractions to dazzling prospects beyond the Atlantic. But he wished to make a good position for himself before he assumed the responsibilities of a husband, and he laughingly promised his parents that he would in all probability become a Benedict as soon as he had returned to England, after the expiration of the term of his voluntary absence. During his residence at Santa Anna he had known little of the refining influence which accrues from the society of the gentle sex; his opportunities for becoming acquainted with ladies being limited to an occasional ball or party at Mariquita. The obese negress, who attended to his household matters, was the only female near in whom he was at all interested, for she attended to his daily wants with all the devotion of a good black servant to a kind white master. Under such circumstances, it was only to be expected that his return to England should be immediately followed by an entrance within that inner circle of homely and attractive influences, where woman holds paramount and undisputed sway.

One of the earliest visits which he paid to friends in London, after his return, was to Broad Street, where he was kindly received by Mr. Sanderson and his daughter, and the urgent invitation of the former, that Robert Stephenson would be a frequent visitor at his house, was responded to by the bronzed and obliging engineer in a considerably literal and generous spirit. Whenever business called him to the metropolis, Robert never failed to make the Sanderson residence a point towards which his steps frequently gravitated; and it was shrewdly surmised by more than one of his partners in the engine factory, that London had for their manager an attraction greater than any connected with the furtherance of the business of the firm. In

October of the year 1828, Robert's attachment to Miss Sanderson was so far pronounced as to allow of its existence being made known to the suitor's father, and in that month George Stephenson was introduced to the young lady who had won the tenderest regard of his son. Parental scrutiny of the prospective daughter-in-law passed off with a most satisfactory impression of the suitability evinced by the lady for the position she was about to be asked to assume, and which she agreed to fill, when a certain momentous question had been put to her, a few weeks afterwards, by her devotedly attached lover.

During the first six months of the year 1829 Robert Stephenson spent much of his time in the society of his affianced bride; a proceeding that called forth at times urgent representations from his partners as to the results to be expected from habitual inattention to the claims of the concern, which he had formerly regarded as of primary importance to all other considerations. But graver and wiser men, even than the subject of our present attention could be supposed to be at the age of twenty-five, have sometimes found themselves unable to withstand the fascination of a loving and lovable woman, and have considered greater penalties than a double journey by stage-coach between Newcastle and London not too much to pay for the pleasure experienced in the companionship of the objects of their affections. The union of Robert Stephenson and Fanny Sanderson, which took place in Bishopsgate Church, on the 17th of June 1829, enabled, however, the engineer to throw off the shackles of the lover, and gave him an additional incentive to devote his energies to the affairs of the factory and the arduous duties of his profession.

Prudently recognising the advantages of keeping their expenditure within the limits of a comfortable, but not lavish, income, the young couple took up housekeeping in Greenfield Place, Newcastle-upon-Tyne, with one servant

for domestic work. It has been said that so careful was the young husband not to indulge in needless luxuries that the furnishing of his drawing-room with a sofa was seriously deemed by him to be quite unnecessary; but, upon the question being debated by Fanny and himself, the resources of a woman whenever engaged in argument with her lover, or her spouse, proved more than a match for Robert's inexperience in household matters in general, or the requirements of a drawing-room in particular. To the last day of her life the will of Mrs. Robert Stephenson was a law to her husband; yet she never appeared anxious to receive from him any such concession.

As soon as the short wedding trip had ended, and his young wife had been installed in her new home, Robert Stephenson determined that no one would have cause in future to doubt either his capacity for business or his power of constant application to the fulfilment of his professional duties. The day fixed for the competition at Rainhill was fast approaching, and he was fully aware that the fortunes of his firm greatly depended upon the way in which the new locomotive would pass through the ordeal of the trial. He knew also that his own reputation, as a mechanical engineer at least, might be permanently made or marred upon that occasion. A weighty responsibility rested upon his shoulders, but his determination to overcome an impediment was only slightly inferior to that of his father, and the first four months of his wedded life were characterised by undeviating attention, on the part of the manager, to the manufacture and fitting of the various portions and gear of the engine for Rainhill. Punctual and methodical even to nicety, he was always to be found at his post, and ready to grapple with any difficulty or emergency. His ready ingenuity or skill usually commanded a remedy for a mishap and suggested a preventive against its recurrence. But if any uncertainty arose as to the best alternative to be adopted at

any time, he was never too proud of his own abilities, or too confident in his own powers, to refrain from calling to his aid the practical experience of his subordinates. During the building of the "Rocket," Mr. Hutchinson, the superintendent of the factory, was frequently called to deliberate with his chief upon important points; and the deserved reliance which was placed in Hutchinson's opinion led to the superintendent being afterwards admitted as a partner in the firm of Robert Stephenson & Co.

Of the many thousands of people who witnessed the victory of the "Rocket," none felt a more sincere glow of satisfaction than the wife of the builder of the famous engine. To Robert Stephenson the construction of that locomotive had presented obstacles almost as great as those which the Chat Moss bog had offered to his father; for mechanical engineering was then only in its tutelage, and the younger Stephenson was necessitated to devise appliances for engine-building, just as the elder had to meet the emergencies of early railway-making, by calls upon his own ingenuity, energy, and application. But in all his perplexities Robert Stephenson found in his wife a sympathising helpmate, ever ready to share his cares, and to obliterate the troubles and anxieties of his daily life by the strength of her affection and the cheerfulness of their home.

The success of the "Rocket" brought fame to the firm from whose factory it had issued, as the harbinger of a new era in the history of the Locomotive and inland conveyance. The time had come when slow-paced travelling engines must be supplanted by swifter and more reliable machines, of which the famous winner at the Rainhill competition was but the pioneer. Writing from Newcastle-upon-Tyne to one of his partners, a few weeks after the victory of his engine, Robert Stephenson said:—"The trials at Rainhill of the locomotives seem to have set people railway mad. . . . We are getting rapidly on with four locomotive engines for Liverpool,

which I am confident will exceed the 'Rocket' in powers." The writer had taken at a bound a position for which many have struggled unsuccessfully during a lifetime. The hour had been propitious to those who had fought in the foremost rank in the battle for the Locomotive, and the victors were not required to wait long for the reward of their stoutness in the contest.

CHAPTER IV.

THE LONDON AND BIRMINGHAM LINE.

AT the age of twenty-six Robert Stephenson had earned for himself no mean reputation or indifferent position in life. His name had been associated prominently with the building and success of the "Rocket," and he was now regarded as a railway engineer whose abilities would force him to the front in future struggles for the extension and consolidation of the great system of transit which his father's energies had largely assisted to inaugurate. Much prejudice regarding railways had still to be allayed, however, considerable opposition remained to be overcome, ere the iron-horse and the iron-road could be expected to be regarded as unquestionable factors in human progress and beneficence.

For a considerable time after the opening of the Liverpool and Manchester line, mistaken ideas as to the effect of railways upon personal interests were not confined particularly to one section of the community. The upper and middle classes alike looked upon the innovation with jaundiced eyes. When the proposal was made to extend the advantages of the railroad to the Midland and Southern shires of England, great uneasiness of spirit prevailed among

the landed gentry; and proprietors everywhere were found declaiming against schemes that were calculated rather to benefit than deteriorate their estates. In rural districts one impression prevailed—the cultivation of farms would be seriously affected; the owner and the farmer would both be beggared; the agricultural labourer would be thrown out of work and into the poorhouse; the rates would be increased, while incomes were being hopelessly reduced; and, saddest thought of all, game-preserves and fox-covers would be relegated to the traditional memories of the past! In the larger towns, even, were the inhabitants roused into a state of alarm as to the dreaded consequences of their near proximity to railways. The London and Birmingham Railway, for instance, was projected so as to afford accommodation to the townspeople of Northampton; but men of influence raised a counter-agitation that resulted in the promoters being compelled to decide that their line should keep at a respectful distance from St. Crispin's handsome borough. Maidstone, the county town, was similarly treated when the first railway in Kent was promoted; for no townsman supported the proposal of the projectors, while the landowners of the neighbourhood opposed a united front to the design. Eton, led by the Marquis of Chandos, publicly rejoiced over the defeat of the first Bill to sanction the making of a line between London and Bristol; but the congratulations of the Etonians were not singular upon that occasion, for the inhabitants throughout the length of the intended route had denounced the proposed railroad in no measured manner.

It will be seen, therefore, that the opposition to an extended railway system was not confined to the upper classes, or to landed proprietors. The corporations and tradesmen of provincial boroughs and towns, indeed, were to be found in the ranks of its most strenuous opponents; as were also the holders of any vested interests that were likely to be prejudicially affected by the iron highway; such

as road trustees and the mortgagees of turnpike tolls, the proprietors of stage coaches and canals, and even petty yeomen and the owners of small patches of land, whose rights to be infringed were of the most meagre character and description.

The success which followed the inauguratory ceremony of the Liverpool and Manchester line, on the 15th of September 1830, brought with it a highly onerous appointment to the younger Stephenson, namely, that of engineer-in-chief to the London and Birmingham Railway. The earlier months of that year had found him engaged in superintending the construction of the line between Canterbury and Whitstable, and also directing the affairs of the engine factory at Newcastle. In quick succession he was appointed engineer of the Warrington and Newton Railway, and of that from Leicester to Swannington. The latter, about sixteen miles long, demanded the exercise of no superior engineering skill until nearing Leicester, where his first important piece of tunnelling was encountered and successfully accomplished by the engineer. Out of a total length of one mile and three-quarters, 500 yards of the tunnel in question ran through dry sand, which necessitated the construction of a wooden shell to support the sides and roof during the building of the permanent brickwork. While this line was in progress a regular correspondence was carried on between Robert and his father, who was then at Liverpool, and the faculty of observation which the son possessed in common with the parent enabled both to improve their fortune, while giving employment to a considerable number of men, with increased comfort, and the means of saving, to the inhabitants of a populous manufacturing town and neighbourhood.

The Snibston Estate, near Ashby-de-la-Zouch, being advertised for sale, Robert Stephenson's geological knowledge and experience led him to conclude that the property contained beneath its surface seams of coal that would enhance its value to any purchaser who possessed a spirit

of enterprise, and the capital necessary to conduct colliery operations on what was then considered a large scale. The estate was in the immediate vicinity of the Leicester and Swannington Railway, and the fact offered an additional incentive to purchase, as the finding of coal so near the line would tend to benefit considerably the undertaking. The engineer lost no time in communicating to his father the opinion which he had formed, and George Stephenson, having inspected the ground, confirmed the conclusion at which his son had arrived. Two Liverpool gentlemen also joined in purchasing the estate, and the elder Stephenson removed to Alton Grange, in order that he might superintend the sinking of the shaft. In 1831 operations were commenced in earnest, and were carried on successfully until the sinkers were forced to cease work on account of the bursting in of water upon them. By the employment of efficient pumping-machines, and the adoption of the principle called "tubbing"—consisting in fixing closely together, and in segments, short pieces of cast-iron cylinder—a water-tight wall was eventually formed down the sides of the shaft, which allowed the sinking to proceed satisfactorily until a depth of one hundred and sixty-six feet had been reached, when the work was retarded by the presence in the strata of a formidable bed of whin, or greenstone. This mass of solid rock, found in such a position, was considered by practical men to be of such an unusual occurrence that George Stephenson was urged to abandon his mining operations altogether. But he was firmly persuaded that perseverance would now, as on many previous occasions, bring to him his coveted reward; and he therefore determined to continue labours that others thought could only terminate in loss and disappointment. To guard against absolute failure, however, he caused the sinking of a double shaft to be commenced at the distance of about a quarter of a mile westward from the "fault" in question, and with the object of keeping clear of the same.

After a further depth of twenty-two feet had been cut through the solid rock which had barred for a time the hopes of the proprietors, the main seam of coal was discovered, after about nine months had been spent in labour and hope, in difficulty and anxiety.

When the workings had been opened out, and a traffic had been established between the Snibston Colliery and Leicester, a considerable impetus was given to the manufactures of the town, while the price of coal was reduced to about eight shillings a ton: a tangible benefit that ensured to the inhabitants an annual saving of forty thousand pounds. Before the opening of the Snibston Mine, distant from Leicester about fourteen miles, that town had been wholly supplied with coal from Derbyshire, brought by canal, and at considerable expense to the consumer. But the pecuniary good thus brought to a populous community did not constitute all the beneficial result of George Stephenson's enterprise and energy, for the mining operations which had been carried out to a successful issue, by offering a salutary example of forethought, industry, and unswerving determination, roused the owners of other collieries in the district to greater activity and zeal in the management of their mines; so that the various improvements that were from time to time effected at Snibston, being open for the inspection of all comers, were afterwards reproduced, with various modifications to suit the requirements of local circumstances, throughout the Midland Counties, to the profit and advantage both of coalowners and miners. Robert Stephenson resembled his father in the power of observation which he exercised in the performance of his daily duties; and to that talent, which he possessed in so remarkable a degree, may be primarily attributed the acquirement of the Snibston estate, and the working of its coal seams for the use and prosperity of the people of Leicester. But before the completion of the Leicester and Swannington line the

young railway engineer had embarked in the first great undertaking of his professional life.

The project for making a railway between London and Birmingham originated in 1824, but was set aside for five years, principally on account of the times being inopportune for speculators investing their capital in such doubtful schemes as railroads then appeared. But the successful completion of the iron highway between Liverpool and Manchester, following as it did upon the decisive victory of the Locomotive at Rainhill, revived the dormant energies of Birmingham projectors till, in the year 1830, two counter-schemes offered themselves for public approval and support. While one party of promoters advocated the adoption of a route by way of Coventry, another was in favour of a line by Banbury and Oxford. The former design was ultimately approved, however, upon the recommendation of George Stephenson, who had been called by the promoters of both lines to decide the important question as to the more favourable character of either—the two sets of projectors meanwhile agreeing to combine their forces in favour of the route selected by the engineer.

The Stephensons, father and son, having been engaged to survey the line of the proposed railway, the principal portion of that duty fell to Robert, who, besides making three distinct surveys of the intended road, covered various portions of the different districts through which he passed, in order to ascertain the practicability of making a deviation at any point with advantage. In the autumn of 1830 the first survey was carried out, and the second was completed early in the following year. The labours thus entailed added considerably to the responsibilities of one who already had the construction of two railways to superintend, besides having the direction of an engine factory at Newcastle, and the working of a large colliery in Leicestershire, continually demanding a share of his personal presence and attention.

Robert Stephenson entered upon the preliminary survey of the London and Birmingham Railway with a pressing consciousness of the arduous character of the duties which he had undertaken, and he not unfrequently prosecuted his labours in the face of determined hostility and violent menace. It is true that the opposition which he encountered did not always proceed from persons who dreaded the Locomotive and the Railroad in general as innovations fraught with ruin to those whose property adjoined the hateful iron-roads. The experience of landowners, whose estates were in proximity to the Stockton and Darlington line, in regard to the increased value of their property which had been effected, as well as the prospects held out to owners along the Liverpool and Manchester Railway, had done something to dispel the groundless fears of the timid and the incredulous. But other sources of antagonism had arisen which also required to be dealt with in a resolute but judicious manner. The large sums which had been paid in many instances for land for railway purposes excited the cupidity of proprietors or their agents, and at times raised the most serious obstacles to the work of the engineer and his assistants; while Press-criticisms, both adverse and absurd, assisted to intensify the bitterness with which the railway system was still regarded in various circles.

In the year 1831 an anonymous pamphleteer—*Investigator*—undertook the task of "proving by facts and arguments" that a railway between London and Birmingham would be a "burden upon the trade of the country, and would never pay." The apprehended inconvenience and fatality which would, according to the writer, be inseparable from such travelling, are thus discussed :—

"The causes of greater danger on the railway are several. A velocity of fifteen miles an hour is in itself a great source of danger, as the smallest obstacle might produce the most serious consequences. If, at that rate, the engine or any forward part of the train should suddenly

stop, the whole would be cracked by the collision like nutshells. At all turnings there is a danger that the latter part of the train may swing off the rails; and, if that takes place, the most serious consequences must ensue before the whole train can be stopped. The line, too, upon which the train must be steered admits of little lateral deviation, while a stage-coach has a choice of the whole roadway. Independently of the velocity, which in coaches is the chief source of danger, there are many perils on the railway: the rails stand up like so many thick knives, and any one alighting on them would have but a slight chance for his life. . . Another consideration which would deter travellers, more especially invalids, ladies, and children, from making use of the railways, would be the want of accommodation along the line, unless the directors of the railway chose to build inns as commodious as those on the present line of road. But those inns the directors would have in part to support also, because they would be out of the way of any business except that arising from the railway, and that would be so trifling and so accidental that the landlords could not afford to keep either a cellar or a larder."

Established usages, as affecting the comfort of regular travellers and casual tourists, were defended by this self-constituted champion of the stage-coach and the King's highway. The prejudices of the upper-ten-thousand were also used to illustrate and strengthen the disquisition of a writer who had chosen as the motto for his treatise the phrase, "No argument like matter of fact is." *Investigator* continues:—

"Commercial travellers, who stop and do business in all the towns, and by so doing render commerce much cheaper than it otherwise would be, and who give that constant support to the houses of entertainment which makes them able to supply the occasional traveller well and at a cheap rate, would, as a matter of course, never by any chance go by the railroad; and the occasional traveller, who went the same route for pleasure, would go by the coach road also, because of the cheerful company and comfortable dinner. Not one of the nobility, the gentry, or those who travel in their own carriages, would by any chance go by the railway. A nobleman would really not like to be drawn at the tail of a train of waggons, in which some hundreds of bars of iron were jingling with a noise that would drown all the bells of the district, and in the momentary apprehension of having his

vehicle broke to pieces, and himself killed or crippled by the collision of those thirty-ton masses."

Fifty years ago such prognostications and reasoning were considered by many to be conclusive arguments against an extended railway system, and Robert Stephenson, while engaged in the survey for the London and Birmingham line, was frequently obliged to act the part of a special pleader as well as that of the engineer of the proposed railroad. Many years after the event, while recalling his experiences, he said :—"I remember that we called one day on Sir Astley Cooper, the eminent surgeon, in the hope of overcoming his aversion to the railway. He was one of our most inveterate and influential opponents. His country house at Berkhampstead was situated near the intended line, which passed through part of his property. We found a courtly, fine-looking old gentleman, of very stately manners, who received us kindly, and heard all we had to say in favour of the project. But he was quite inflexible in his opposition to it. No deviation or improvement that we could suggest had any effect in conciliating him. He was opposed to railways generally, and to this in particular. 'Your scheme,' said he, 'is preposterous in the extreme. It is of so extravagant a character as to be positively absurd. Then look at the recklessness of your proceedings! You are proposing to cut up our estates in all directions for the purpose of making an unnecessary road. Do you think for one moment of the destruction of property involved by it? Why, gentlemen, if this sort of thing be permitted to go on you will in a very few years *destroy the nobility!*'" The engineer and his companions quitted Sir Astley's presence, considerably annoyed to find that the baronet cherished an inveterate hatred to a project that was calculated to benefit no one more than himself!

In the year 1832, after a hard contest, the London and Birmingham Railway Bill was passed by the Commons.

The Lords, however, did not consider that the promoters had made out their case, as the following finding testifies:—"It does not appear to the Committee that they have made out such a case as would warrant the forcing of the proposed railway through the lands and property of so great a proportion of the dissentient landowners and proprietors." As the principal witness for the projectors of the line, Robert Stephenson's evidence was subjected to a long and determined sifting by the opposing barristers, and the cool, collected, and resolute bearing of the engineer, when under a most searching cross-examination, drew from Lord Wharncliffe, one of the Grand Allies who owned the Killingworth Colliery, where young Stephenson had done duty as a viewer's apprentice, the first words of sympathy that the engineer received after the rejection of the Bill—words, too, that were often recalled by him when reviewing, in the days of his fame, the opening struggles of his professional career. Taking Robert aside, the kindly nobleman, who had presided over the Committee of the Lords, said:—"My young friend, don't take this to heart. The decision is against you; but you have made such a display of power that your fortune is made for life!"

Disappointed, but not disheartened at the result, the projectors called together a meeting of gentlemen who were favourable to the scheme. Sixteen members of the Upper and thirty-three of the Lower House of Parliament were present at the meeting, of which Lord Wharncliffe was the chairman. Having unanimously resolved that a railway from London to Birmingham would "be productive of very great national benefit," a further resolution was in like manner carried, in the following terms:—"That the Bill for effecting this important object having passed the House of Commons, after a long and rigorous examination of its merits, it must be presumed that its failure in the House of Lords has arisen from apprehensions on the part of land-

owners and proprietors respecting its probable effect on their estates, which this meeting firmly and conscientiously believes to be ill-founded." This deliverance produced a telling effect throughout the country, and was the means of bringing over to the side of the promoters many whose opinions had wavered in regard to the utility of public railways. The friends of the scheme had also a weighty argument to wield, namely, the fact that Lord Sefton and Lord Derby, who had previously offered a strenuous opposition to the project of a line between Liverpool and Manchester, were now ranged on the side of the supporters of the proposal to lay down an iron highway between Birmingham and the metropolis.

When hereditary landowners of high character and large interests had been won over to the side of the assailants on the citadel of popular prejudice, the resistance of the defenders of that fortress grew gradually weak and unfitted to resist effectively the onslaught of the besiegers. But there remained, however, a small but stubborn section within the garrison, who had resolved to fight to the last, and it was necessary to subdue that factional opposition by favours rather than by force. Accordingly, the bribe effected what the battery could not accomplish, and the defenders of personal right against public advantage laid down their arms after considerable sums of money had been distributed over the capitulation! The conciliation of the opponents of the line caused a heavy item to be added to the original estimate for the purchase of land for its construction, for what had been valued at £250,000 actually cost the company about £750,000. The most formidable opposition having thus been silenced, the promoters were allowed to proceed with their measure.

Application to Parliament having been renewed, the Bill authorising the formation of the London and Birmingham Railway received the Royal assent on the 6th of May 1833. On the 7th of September following, Robert Stephen-

son was appointed engineer-in-chief for the whole line, with a yearly stipend of £1500, and a further annual sum of £200 for contingent expenses. But he had not received this well-merited reward for three years' assiduous devotion to the interests of the promoters without an attempt being made to deprive the engineer of the fruits of his toil; for a powerful party of the former opponents of George Stephenson, at Liverpool, endeavoured strenuously, but ineffectually, to disparage the ability of the son, and thereby avenge themselves for the chagrin they had experienced through the falsification of their adverse prophecies regarding the father. "Robert Stephenson," these gentlemen repeated in influential ears, "is without a doubt very clever, and promises to become of some note in his profession, *when he has gathered age and experience;* but then, you see, he is still young—*very young* to undertake the responsibility of such a large affair as your railway—and you cannot put an old head upon young shoulders." The manner in which the engineer acquitted himself during the performance of his task, however, proved that his constructive genius was not to be measured by the number of his years, but rather by the use to which he had applied the days and weeks of his youth and early manhood.

When Robert Stephenson, at the age of thirty, commenced the construction of the London and Birmingham line, the science of railway-making was only in its infancy. His father had begun to lay down an iron-road between Liverpool and Manchester with but a hazy notion of the general requirements of the work before him. The consideration of details was invariably left by the elder engineer until forced upon his notice by the daily progress of the task which he had undertaken. But George Stephenson's resources, when confronted by a difficulty, were large, and he had great confidence in his own powers. Robert Stephenson, on the contrary, had no exalted opinion of his own abilities.

Shortly after his return from America, a friend had one day congratulated him upon his advancement in life. The reply was characteristic, and showed Robert's true nature. "I can assure you," young Stephenson said, "I sometimes feel very uneasy about my position. My courage at times almost fails me; and I fear that some fine morning my reputation may break under me like an egg-shell." He could never wholly conquer the feeling which had prompted such an utterance.

Never leaving the future to take care of its own difficulties, Robert Stephenson decided that plans should be made of every portion of the one hundred and twelve miles of ground over which the railway was to be carried. In accordance with that resolution he made a working survey of the whole route, and prepared drawings for all the work in detail, with full descriptions, specifications, and calculations of the material and labour required. The line was divided into five districts, four of which were severally under the superintendence of a principal assistant-engineer: the first district, extending from Camden Town, London, for a distance of nine miles, being reserved for the personal supervision of the engineer-in-chief, who had removed his home-quarters from Newcastle to a comfortable domicile at Haverstock Hill, Hampstead Road, where he principally resided for many years.

The first sod of the London and Birmingham Railway was cut on the 1st of June 1834, at Chalk Farm, near the metropolis; eighty miles of the intended line having been let for construction under contract. Difficulties of the most formidable character were encountered during the progress of the works; and the experience which Robert Stephenson had gained in mining operations enabled him not only to subdue the natural obstructions that lay in his path, but peculiarly fitted him for utilising to the fullest possible extent the labour, implements, and material at his command.

The tunnels were eight in number, and extended to a total length of seven thousand three hundred and thirty-six yards. Primrose Hill was the first rising ground encountered, and a close, compact bed of dry clay was passed through for a length of eleven hundred and sixty-four yards. Though free from water, exposure to the atmosphere caused the clay to swell rapidly, on account of its absorbent nature; consequently the brickwork had to be built of an unusual thickness, in order to guard against failure, from the great pressure of the outer clay upon the lining of the tunnel. The chalk ridge at Watford was penetrated for about eighteen hundred yards; while shorter tunnels were cut at Northchurch, Lindslade, and Stowe Hill. All these works, however, were of minor importance when compared with the difficulties which presented themselves in the construction of a tunnel through the ridge at Kilsby.

One of the most interesting works of its character in the country is undoubtedly that of the Kilsby Tunnel. In length about two thousand four hundred yards, its average depth is one hundred and sixty feet from the surface. By the sinking of two shafts, for the purpose of ascertaining the nature of the stratum through which a boring was to be made, shale of the lower oolite was found at the required depth, and the contract was made for the works upon the assumption that the bed of shale extended, with but little variation, throughout the distance between the test shafts. But such, unfortunately for the contractors, was not the case, for upon a number of working shafts being sunk, in order to remove the excavated soil, it was found that a bed of sand and gravel extended in the line of the tunnel, through the ridge, for a distance of four hundred yards. This unexpected quicksand contained a large quantity of water, and the knowledge of its existence was only kept from the engineer and the contractors, before the signing of the contract, by a few feet of ground that intervened be-

tween an edge of the sand basin in question and one of the trial-shafts.

The discovery thus made gave occasion to those who had opposed Robert Stephenson's appointment to renew the warnings they had given as to his disqualification for such an important position, on the assumed ground of his lack of age and experience. The directors of the company—one committee of whom met in London and another at Birmingham—were filled with consternation at the result ascertained at the Kilsby ridge; and, goaded by the reproaches and innuendoes of the prophets of evil, Captain Moorsom, the secretary and adviser to the Board, was despatched to Kilsby for the purpose of urging upon Robert Stephenson the propriety of calling to his assistance the advice of other engineers. But the engineer-in-chief saw at once that some of his old enemies had been at work to his disparagement, and when Captain Moorsom delivered the commission with which he had been entrusted by the directors, the engineer quietly answered, without any display of his inward feelings on the matter:—"No; the time has not come yet for extra professional advice. I have already decided what to do. I shall pump out all the water, and then drive the tunnel under the dry sand. Tell the directors not to be alarmed, and that all I ask is time and fairplay. If I cannot get rid of the water, I will then think about soliciting the help of other engineers." The self-control and firmness which were exhibited in the bearing and tones of the younger Stephenson, as he uttered an answer to the message of his employers, created a most favourable impression in the mind of the secretary, who became from that moment his enthusiastic friend and supporter. On the captain's return to the committee, he reported that Robert Stephenson deserved the entire confidence of the Board.

Our engineer immediately set to work to overcome the difficulty which had threatened to cast a shade of doubt

over his professional repute, and in a comparatively short space of time he had placed on the works, at the Kilsby ridge, 1250 navvies, together with 200 horses and thirteen steam-engines. Shafts with wooden "tubbing" were driven into the quicksand, for the purpose of drawing off the water which it contained; and for nine months, during which period the pumping continued, nearly 1800 gallons of water per minute were drawn from the bottom of the shafts. The obstruction being at length successfully overcome, the tunnelling operations were continued under the dry sand-bed, to the satisfaction of the engineer and his assistants, the gratification of a majority of the directors, and the mortification of a few who had added considerably to the tear and wear of Robert Stephenson's life, at an anxious time, by their prying impertinence, criticisms, and conceit.

Another portion of the line that offered considerable impediments to the progress of the works was the Blisworth Cutting, out of which not less than a million cubic yards of earth, stiff clay, and hard rock were dug, quarried, or blasted. But the greatest difficulty experienced in the excavation of that long, deep groove, which extends to one mile and a half, with a depth in some places of sixty-five feet, was that presented by beds of loose shale, so saturated that incessant pumping was at times necessary to prevent a stoppage of the works from the excessive flow of water. At the end of eighteen months, the contractor for that portion of the railway was compelled to abandon his undertaking, and Robert Stephenson was thus obliged to take into his own hands, in the interests of the company, another division of the line which had proved, like that at Kilsby, a source of disappointment and loss to the contractor who had engaged to complete its construction. Briefly, out of thirty contracts which were entered into by twenty private firms for the completion of various portions of the line, ten contracts were abandoned by eight of the firms in question,

while out of these ten unfulfilled engagements eight were finished, at the instance of the company, under the direction of the principal engineer.

The average number of men employed in the formation of the London and Birmingham Railway—the first Metropolitan line that was worked by locomotive power—was twelve thousand, or rather more that one hundred and seven men to each mile constructed. In about four years and three months the labours of that large army were completed, and the formal opening of the railroad took place on the 15th of September 1838. The London directors, with a select circle of their friends, and the chief officials of the company, celebrated the termination of the great undertaking by proceeding from the Euston Square Terminus to Birmingham, where the party was joined by the Local Committee of the Board, and a dinner at Dee's Royal Hotel brought the day's proceedings to a close. The locomotive attached to the single train of official excursionists and their guests was under the charge of the engineer-in-chief, who experienced a feeling of sadness as he passed over the important iron highway which had been to him a source of intense anxiety and assiduous toil during the eight years which had elapsed since the day that he set out to make his preliminary survey of the route. One cause in particular had conspired to depress and sour the spirit of Robert Stephenson upon an occasion that should have conduced only to the most pleasurable of sensations.

Before mounting the engine that was to make the inaugural passenger trip upon the line, the engineer had read a newspaper article containing malicious reflections upon his father. The baseness of the insinuations that were displayed in that personal attack by an anonymous writer was intensified by the time chosen for the publication thereof—namely, the morning of the day for opening the first of a series of great public railways that will always be asso-

ciated in the history of English enterprise with the name of Stephenson. The author of the article in question, as was shrewdly suspected by the son of the famous engineer who was slandered, proved to be a director of the line that had just been completed, the works of which are now considered as memorable models of railway engineering. Justice, even to a slanderer, demands the further statement that the director, some years after the line between London and Birmingham had become an accomplished fact, asked pardon from the son for the indignity which had been committed against the reputation of the parent. That tardy request was freely and fully granted by Robert Stephenson.

CHAPTER V.

A REVERSE OF FORTUNE.

THE successful opening of the London and Birmingham Railway gave an impetus to the projection of other lines throughout the country, and Robert Stephenson's bridges, tunnels, cuttings, and other works, on the first great railroad from an important centre of industry to the metropolis, served as conspicuous examples of railway engineering to his contemporaries; while the drawings and plans used in the construction of that iron highway were accepted by his professional brethren as reliable precedents for their guidance and authority in other undertakings. But the career of the younger Stephenson was not one of unalloyed prosperity, and we have now to deal with circumstances in his experience which tended to embitter what might otherwise have been the most pleasurable period of his busy life.

While his agreement with the London and Birmingham directors prevented him from personally superintending the laying down of any other railroad during the construction of their line, the terms of his appointment did not preclude him from attending to matters pertaining to his personal interest in the engine factory at Newcastle, or from accept-

ing commissions as a consulting engineer. In the year 1831, a speculative scheme was set afloat for connecting, by a railway, certain lime quarries near Stanhope and the Medomsley coalfield. The proposed line was to run through a sparsely populated and somewhat acclivous part of the county of Durham, for a distance of fifteen miles; the rising nature of the ground necessitating the working of the traffic over a series of heavy inclines. Before the era of public railways, the tramroads of the north were constructed without Parliamentary powers having being obtained for the purpose. Way-leave for a period of years, at an annual rental for the ground taken, could generally be obtained from landowners without difficulty. While this system of leave-taking obviated applications to Parliament, with the large outlay for preliminary expenses consequent thereupon, the arrangement caused each shareholder in a company, for whose benefit a tramroad was constructed, to be personally liable for the debts of the concern. In short, the old colliery proprietorships of the North were on precisely the same footing as other private firms, and their waggonways were, and are, held on lease, except in cases where such lines pass over land that forms part of the property of the interested collieries.

It was under way-leave arrangements that the original Stanhope and Medomsley line was laid down; the first agreements with landowners being made in April 1832. It required however but a very short time to demonstrate, what had been evident to many from the first, that such an undertaking could never prove remunerative, as it was shut in from any large outlet and demand for the lime and coal which the railway had been primarily devised to carry. Under the circumstances, two of the projectors considered it prudent to escape from a liability that promised nothing but failure to all concerned, and these gentlemen had the good fortune to effect a transfer of their interests in the affair

upon terms very favourable indeed to themselves. But some one must make good the loss that was being sustained, and those who remained in the proprietorship adopted the bold, but only feasible, course for retrieving their position, by the expedient of extending the line, so as to open up a communication with the shipping market of Tyneside.

Without an Act for the incorporation of the company, and encumbered with an annual rental exceeding £300 for each of its thirty-five miles of road, the Stanhope and Tyne Railway struggled into existence under the most unfortunate circumstances that may well be conceived, for one of the first transactions of the management was to draw a bill of exchange. The scheme, however, appeared to offer great inducements to investors, especially at a period when the railway system was attracting the special attention of capitalists to what in general promised to become a highly important and safe species of investment. The stated capital of the company was £150,000, in £100 shares, but out of the 1500 into which the stock was divided, not more than 1000 shares were ever paid upon, leaving 500 to be allotted to two projectors as a part-remuneration for services supposed to be rendered in floating the company. In addition to the gratuitous receipt of one-third of the shares, these gentlemen secured for themselves the concession of one-half of the remaining profits, after a dividend of five per cent. had been paid to the proprietors. The directors were also empowered to create a further share-capital to the amount of £50,000, and to raise an additional sum of £150,000 by the issue of debentures. Such, briefly, were the circumstances attendant on the formation of the Stanhope and Tyne Railway Company, the deed of settlement of which was executed in February 1834, that is to say, nearly two years after the primary way-leave agreements with the landowners had been effected.

Unfortunately, Robert Stephenson was consulted by the

directors in regard to the making of the line, and he was persuaded to accept, in lieu of his professional fee of £1000, ten of the company's shares. This was done purely as an act of good nature on the part of the engineer, and without a thought of the consequences that might ensue to himself through the mismanagement of men who had but little capital of their own to squander over an unprofitable scheme. Besides, at that time the younger Stephenson was wholly unaware of the fact that, as a shareholder in an unincorporated railway company he would, in the eye of the law, be personally liable for any loss that might be sustained over and above the amount which he held in shares. When he awoke to the consciousness of the folly which he had thus committed, it was too late either to retrace the fatal step or to take precautions to mitigate the severity of the impending evil which in ignorance he had invoked. By bitter experience the engineer was taught a salutary lesson.

The extension of the Medomsley Railroad to the mouth of the Tyne promised to render much needed facilities in transit for the produce of the extensive coalfield through which the new portion of the line was intended to pass. At great cost to the company, houses and other buildings, wharves and quays, were purchased at South Shields, where staiths were erected for the shipment of coal. Thus far well. Had the directors of the unfortunate company confined their attention to the construction of proper works for the development of a remunerative traffic, a result that was quite within their province and power to effect, no one could have taken exception to their proceedings; but, not content with the great responsibility which the company had assumed, without the protection to individual shareholders which would have been secured by an Act of incorporation, the directors recklessly embarked in another undertaking which hampered, rather than benefited, that one with which they were more immediately concerned.

The Durham Junction Railway was projected in March 1835, and some of the local proprietors of the Stanhope and Tyne railroad considered the new venture so fraught with advantages to the older project as to justify the directors of the latter in subscribing not less than £40,000 out of the total of £80,000 which had been proposed as the share-capital of the new company. That resolution was accordingly carried into effect, and with a disastrous result. Compelled to enter into engagements, upon almost ruinous terms, the Durham Junction scheme was kept afloat for a time at an expenditure of its capital, and by raising money upon bills of accommodation at excessive, if not usurious, rates of interest. Indeed the negotiation of loans appear to have constituted a principal part of the labours of the directorate. The fortunes of the Stanhope and Tyne Railway were so closely bound up with the fate of the Durham Junction line that both must now stand or fall together; but the efforts put forth to stem the tide of embarrassment and ruin only served to render the ultimate catastrophe more desolating in its character.

At the close of the year 1834 the liabilities of the Stanhope and Tyne Railway Company had assumed, for such a proprietorship, overwhelming proportions, while the expenditure amounted to upwards of £226,000; of which sum £100,000 had been paid into the coffers of the concern by the shareholders, £60,000 had been received on mortgage of the company's property, and more than £66,000 had been raised on bills. The day of reckoning, which the directors felt must come sooner or later for the exposure of their daring disregard of the confidence which had been reposed in their management by unwary investors, was deferred for a time by a further issue of debentures to the amount of £24,000. To silence the more clamorous of their money-lenders, more loans were negotiated, more bills were accepted. But the period that was to end a systematic

course of double-dealing and chicanery came at length, and laid bare the true position of the ill-fated railway company.

We have already alluded to the depression that weighed upon the spirit of Robert Stephenson as he journeyed over the line between London and Birmingham on the day of its formal opening. The liability which his connection with the Stanhope and Tyne Railway incurred had increased the bitterness of his feelings on that occasion. The case, as presented to the mind of the engineer, was a doubtful one. He held shares in the company to the nominal amount of £1000, and till recently he had assumed that his pecuniary interest in the undertaking would be desirably augmented by the development of traffic on the line, and a consequent increase in the value of its shares. But adverse rumours regarding the management had lately reached his ears, and although he knew not the full extent of the evil that threatened him, sufficient had been divulged to excite his fears and render him apprehensive of the future. As he stood, therefore, on the locomotive that carried him, as if in triumph, over the great iron highway which had been constructed under his superintending energy and skill, the engineer experienced a strange, undefinable dread of an approaching disaster, which might not only deal a fatal blow to his own prospects, but retard the progress of English railway enterprise, by confirming doubts which still existed in many quarters, both as to the utility of such a species of transit, and the safety of that kind of speculation.

Although some of the works on the London and Birmingham line still remained to be completed, the opening of that railway relieved Robert Stephenson from much of that close application to its requirements which had hitherto distinguished his connection with it as the engineer-in-chief. Opportunities were now to be afforded to him for giving greater attention to other undertakings, upon which he had been consulted in common with his father. Indeed, it is

not too much to say that George Stephenson would never have been able to direct simultaneously the construction of so many separate railways, of which he was ostensibly the sole engineer, had he not been greatly assisted by the devotion, talents, and industry of his eminent son. In 1839 and 1840, not less than 321 miles of railroads, constructed by the elder Stephenson, more or less with the assistance of the younger engineer, were added to the railway system of the country; that mileage being opened for the accommodation of the public during these two years. The lines in question comprehended the Birmingham and Derby, opened in August, and the Sheffield and Rotherham, in November 1839; also, in the following year, the Midland, the York and North Midland, the Chester and Crewe, the Chester and Birkenhead, the Manchester and Birmingham, the Manchester and Leeds, and the Maryport and Carlisle railways. Although in the majority of these undertakings the services of Robert Stephenson were never conspicuous, still his advice was always at the command of his father, and one of the more important of the lines named—the North Midland, from Derby to Leeds—was almost wholly constructed under Robert's personal superintendence.

But his professional labours were not confined to English projects, nor to those with which the name of his father has been more prominently identified than his own; for we find him, in the year 1839, invited to France, Switzerland, and Italy, for the purpose of advising on projected railroads in these countries. During his visit to France he became intimately acquainted with Mons. Paulin Talabot, an engineer of eminence, whose opinions commanded respect in engineering and financial circles, not only in his own country, but throughout the Continent. The English engineer and his French *confrere* were afterwards engaged, along with Signor Negretti, an Austrian member of their profession, to survey the Isthmus of Suez, and decide the

mooted point of the respective level of the Mediterranean and the Red Sea. On his return to England, Robert Stephenson was again actively employed in the consolidation of the railway system. Meanwhile the affairs of the Stanhope and Tyne concern had gone from bad to worse, until the true position of the company could no longer be kept in any measure a secret from the world.

In the year 1839, the pecuniary results of the traffic over the first portion of the unfortunate railroad were found to be so ruinous that the directors were compelled to abandon that source of loss and embarrassment. Consequently, the line between Stanhope and Medomsley was disused, in the vain anticipation that the remaining mileage might be profitably worked, and the company thereby enabled to tide over its difficulties. In the forlorn hope, however, the directors were doomed to disappointment. The lime quarries, for which a rental of £2000 per annum had to be paid in terms of the lease, could not be worked, even at the smallest profit, without railway facilities for the conveyance of the limestone, and the closing of the quarries followed closely upon the stoppage of the traffic over that section of the line. While therefore the original scheme had for the most part been relinquished as unprofitable, its desertion still left an annual rent-charge against the company exceeding £2000. Eventually, the final crash came, and to the consulting engineer of the mismanaged railroad the disaster threatened to be utterly ruinous in its character.

Towards the close of the year 1840, Robert Stephenson was made aware of his full responsibility as a shareholder in the Stanhope and Tyne Railway. The company's creditors were clamouring earnestly, and would not be pacified with anything short of payment of their demands. It was generally known that the engineer was one of the few shareholders who could be regarded as a capitalist. For a series of years he had been in receipt of a superior income,

and his expenses were moderate in the extreme for one in his social position. It was admitted, too, that he always shunned investments of a doubtful or speculative nature. Besides, he had earned for himself a splendid reputation, and would not suffer it to be tarnished without putting forth an effort for its protection. In this manner did the creditors of the ill-fated company reason among themselves, and their estimate of the status and disposition of Robert Stephenson was a just one. When the whole truth was plainly placed before him he could not credit the announcement. He had felt that any day might find him called upon to pay some hundreds of pounds, in common with the other shareholders, and in order to effect an arrangement with those by whom the company, as a body, would be regarded as a liquidating debtor. It was hard to believe that he could be made personally liable for the whole amount due to creditors of the association. Such, however, was the legal aspect of affairs.

When the engineer received a clear intimation that the holders of certain bills, for the due honouring of which the shareholders were responsible, would certainly look to him for payment, a glimpse of the actual truth dawned upon his mind. He was further enlightened when a bill which the directors had dishonoured came to him with a demand for the amount named thereon. Consulting his solicitor, he found that ruin stared him in the face. The bitterness of the thought was intensified by the fact that his own careless act, as well as the audacious conduct of others, had materially contributed to the terrible position in which he found himself. At his instance steps were at once taken to disclose the true state of the company, and to adopt measures for meeting honourably liabilities which the directors had in the most reckless manner incurred. At a meeting of the shareholders it was decided to dissolve the association and to form a new company, which would take

over the property and debts of the old concern, and apply to Parliament for incorporation, the capital being fixed at £400,000. As creditors were pressing their claims, it was resolved that the new capital should be applied in the first place to the payment of these debts, and that the most rigid economy should be carried out in the management of the new company, so as to give the shareholders a chance of being extricated from the disastrous circumstances.

A searching inquiry into the affairs of the dissolved partnership disclosed the fact that, while the liabilities amounted to not less than £440,800, the assets of the concern, even at the most liberal valuation, did not exceed £307,400—leaving a probable deficiency of £133,400. The most strenuous efforts were put forth by the monied shareholders of the old association to raise the capital required for floating the new, and the result was so far successful that in ten days the sum of £250,000 was subscribed; while the remaining shares for £150,000 were shortly afterwards taken up. In the subscription list the name of Robert Stephenson was placed for £20,000, and his instalments were paid promptly as these became due. To keep his engagements in this matter, however, much self-denial was required from the engineer. Writing to a friend, on the 4th of January 1841, Robert Stephenson said:—"All my available means must now be applied to the Stanhope and Tyne. On the 15th of this month I have £5000 to pay into their coffers. The swamping of all my labours for years past does not press heavily on my mind. It did so for a few days, but I feel now master of myself; and though I may become poor in purse, I shall still have a treasure of satisfaction amongst friends who have been friends in my prosperity." He had resolved to grapple bravely with adversity.

Hoping to change the fortunes of the concern by an alteration of the designation thereof, the application to

Parliament for an Act of incorporation prayed for the concession to be granted to the Pontop and South Shields Railway Company. But the legislative powers which the petitioners sought were not to be granted without opposition, for influences that had proved the principal cause of the failure of the old scheme now endeavoured to blight, at the outset, the prospects of the resuscitated association. A counter petition was presented to both Houses, and the opponents based their arguments against the company's Bill on the groundless assumption that the project was simply a conspiracy, concocted by the more affluent of the shareholders, to wrest out of the hands of the poorer proprietors the interest of the latter in an undertaking that was just on the eve of becoming profitable. In spite of the absurdity that was involved in such a palpable misstatement of the case, the measure appeared little less than one of spoliation to a section of those who were called to adjudicate upon its character, and on the Bill coming before the Upper House a noble lord denounced it in no flattering terms. At length, however, the prayer of the promoters was granted, and the Bill authorising the incorporation of the Pontop and South Shields Railway Company received the Royal assent.

While the unfortunate proprietors of the Stanhope and Tyne Railroad were seeking for a Parliamentary loophole by which to escape from their difficulties, the extension of the railway system throughout the kingdom had not occupied a prominent position among the questions that absorbed public attention. Men had been wearied by the feverish struggles and anxieties which had characterised the advent of steam locomotion, and had, for a time at least, been content to rest in retirement from the active prosecution of new schemes. But the quietude of speculators was not to be of long duration, for George Hudson had appeared at Westminster, and his was not a spirit to allow investors

a lengthened respite from the bustle and excitement concomitant to the projection of dazzling undertakings.

The Parliamentary session of 1841–42 saw not only the passing of the Pontop and South Shields Act, but one for the formation of a railway between Darlington and the metropolis of the North. While the former of these was only of interest to the shareholders of the company, and a few who felt aggrieved at the failure of the original scheme, the Newcastle and Darlington Junction Railway was an undertaking that commended its importance to the country at large, for it gave promise that the still greater project of an unbroken line from London to Scotland was in the possible and not far distant future. Throughout his life success never rendered Robert Stephenson's love for his old home, near the banks of the Tyne, less ardent or sincere than when, as the son of a colliery enginewright, he had attended Mr. Bruce's school, or, as the manager of the Forth Street Works, he had taken his London bride proudly to their house in what he always delighted to call his "dear old canny town." It is therefore no exaggeration to say that even the victory which had been achieved in the Parliamentary Committee Rooms, for the Pontop and South Shields Railway Company, gave to the engineer, whose whole savings had been absorbed by that venture, not half the pleasure that he experienced upon learning the fact that Newcastle-upon-Tyne was to reap the advantages of railway communication with other parts of the kingdom. His satisfaction was intensified when, shortly after the passing of the Bill, he received his formal appointment as engineer of the newly authorised line.

The construction of the Newcastle and Darlington Railway extricated the Pontop and South Shields undertaking from the embarrassing circumstances which had surrounded its conception, for both schemes proved highly successful. This gratifying result, so far as regarded the latter at least,

was largely to be attributed to the fact that the requirements of the greater local line necessitated the purchase of the less important railroad, which was effected upon terms advantageous to both companies. Thus was removed from Robert Stephenson's pathway to fame an obstacle which had threatened to involve him in endless difficulties, if not in a crushing disaster. But the lesson with which the experience was fraught was a useful one. To the close of his life he would never again receive payment for professional services otherwise than in hard cash or its equivalent.

The year 1841, while it brought to him threatened insolvency, with its attendant anxieties, was also darkened by the shadow of that great sorrow that was so soon to fall upon his home. The beloved partner of his joys and disappointments had for some time been under medical treatment for a malady the most horrible, perhaps, to which humanity is liable. Cancer, malignant and incurable, had laid its loathsome hand upon Mrs. Stephenson, and her husband was informed that, although she might live for years, medical skill might assuage the agonies of the patient, but dared not to anticipate the eradication of the disease. This sentence of separation from the only being on earth who had shared, with his father, Robert Stephenson's most ardent affection, fell with stunning effect upon the spirit of him who first heard the announcement from the doctor's lips. But public functions must not humour private feelings, and our engineer, during the remaining months of Mrs. Stephenson's life, had frequently to rush from place to place with an aching heart; his sadness all the more depressing because the claims of his profession interposed an insurmountable barrier to the gratification of his daily desire to be present by the couch of her whose earthly existence was slowly and painfully ebbing away. The following entry was made in his diary under date 4th of October 1842:—"My dear Fanny died this morning at

five o'clock. God grant that I may close my life as she has done, in the true faith, and in charity with all men. Her last moments were perfect calmness." The interment took place in the churchyard of Hampstead seven days afterwards. On her deathbed she strongly urged her husband to take another wife when she had gone. Her slightest attainable wish had always been gratified since their marriage. The last she expressed, however, was never fulfilled. Robert Stephenson did not marry again.

CHAPTER VI.

THE GREAT RAILWAY MANIA.

At the age of forty Robert Stephenson found himself in the highest rank as a civil engineer. His achievements gave incontrovertible evidence of his prominent professional position. His name, associated with that of his father, had been identified with the consolidation and extension of the railway system in his own country and on the continent. In his hands the ill-conditioned locomotive of 1828 had become a speedy and reliable motive-power, the merits of which had been admitted by former detractors. His success no doubt had been gained in a large measure by his own industry and ability, as well as the faculty he possessed of acutely observing and profiting by the conceptions of others. It was also to be attributed to his early training and the wholesome discipline he had experienced while struggling earnestly with his father against the combined forces of popular prejudice, professional rivalry, and personal impediment. Inured to opposition and obstacles, he pursued his career until his transcendant genius was perceived and acknowledged, and his stupendous constructions had given an interest and lustre to his name.

The opening of the Newcastle and Darlington Junction

line, on the 18th of June 1844, gave occasion for the display of considerable enthusiasm on the part of the population of Tyneside. Newcastle rejoiced over the event, and the colliery villages, as well as the towns on the banks of the coaly river, lent goodly numbers of their inhabitants to assist the capital of the North in commemorating the completion of an important work, by which she had been brought almost into direct railway communication with the metropolis of the kingdom; a work, too, carried out under the superintendence of one of her own most gifted sons. The terminus of the line being at Gateshead—the High Level Bridge, which connects the north and south banks of the Tyne by rail, was not opened till 1849—the sister borough put on her holiday attire, while the Mayor and Corporation waited with an address of welcome to the "Railway King," George Hudson, and his brother directors, upon the arrival of the first passenger train to Tyneside from the South. On the evening of the auspicious day a banquet was given in Newcastle in honour of the occasion, at which George Stephenson and his distinguished son received an enthusiastic ovation. The completion of a great chain of railways from the Thames to the Tyne, and the jubilation that followed thereupon, may have contributed not a little to that speculative madness which infested different ranks of English society shortly afterwards.

The advantages demonstrated by the traffic over the East Coast Railways, from London to the south bank of the Tyne, speedily revived a project which had lain in abeyance for some time, but which offered considerable inducements to investors, now that direct communication by railway had been extended so far northwards. The scheme in question was that of a line from Newcastle to Berwick, with the connecting link of a High Level Bridge between the railways north and south of the river at Newcastle. George Stephenson had previously identified himself with the project

of a Northumbrian railway, and as he was conversant with the whole ground of the newly proposed line, the promoters naturally consulted him in regard to the engineering phases of the question. The route formerly surveyed by the engineer having been again recommended by him, it was adopted by the committee, and steps were taken to secure the necessary Parliamentary powers for the company. These were not granted, however, without considerable opposition from the projectors of a rival railroad. Indeed, in the contest that ensued, the Stephensons had to fight another battle for the Locomotive. But now the opposing forces were ranged on the side of what has been termed—perhaps for lack of a more suitable designation—"The Atmospheric Railway." It may here not be out of place to describe briefly the principle of the motive power that gave rise to the title.

In the year 1688, one Denys Papin drew attention to an atmospheric apparatus, by means of which pistons placed at one end of a long tube were set in motion by a partial vacuum being created therein, through the working of air-pumps fixed at the other end of the tube. But, coming to the present century, George Medhurst, a mechanical engineer of London, in the year 1810, proposed a plan for the application of atmospheric pressure in the conveyance of letters, goods, and passengers. The contrivance devised and advocated by Medhurst was that of enclosing letters and papers in a light vessel, the bulk of which would fill the area of a tube. By forcing air into one end of the tube, it was calculated that the vessel and its contents would be propelled at a great velocity to the other extremity. The principle was practically adopted at a more recent period by the Pneumatic Conveyance Company of London, and is now used in various places for postal purposes. Medhurst extended his idea by proposing that the tube should be made of sufficient capacity to allow a carriage with four

wheels, and carrying passengers and goods, to run on an iron road through the tunnel thus formed. Important improvements were subsequently added by the ingenious inventor to his original plan for the conveyance of passengers; but it is sufficient for our present purpose to notice the atmospheric mode of propulsion adopted by the promoters of English railroads on which that principle was used.

The modern "Atmospheric Railway" provided for the transit of trains on the *outside* of the tube in which the motive power was generated by the pressure of the air. Between each line of rails was laid a continuous pipe or tube, which was divided by separating valves into convenient lengths for exhaustion. Steam engines for working the air-pumps were fixed at suitable intervals along the road, for the purpose of creating a vacuum in each length of pipe. Without reduction of speed, the separating valve of each section of the tube was opened successively by the approaching train, the leading carriage of which was connected by an iron plate with a piston moving within the tube by atmospheric pressure. In the course of a journey, when the connecting plate had passed the separating valve of a section, the valve closed again by its own weight. On the top of the tube was a longitudinal opening, which extended from one extremity to the other. In that opening travelled the iron plate which connected the train and the piston, the carriages moving along from one section of the tube to the next, and so on in succession until the end of the tube at the terminus was reached. Such, briefly, was the principle of the apparatus that gave to a line upon which it was adopted the distinguishing title of an "Atmospheric Railway."

By the time that George Stephenson's scheme for a railroad between Newcastle and Berwick had assumed a tangible shape, the substitution of atmospheric pressure for locomotive power in the working of lines had become exceedingly popular.

The system had been warmly espoused by several eminent engineers, and had found favour in influential Parliamentary circles. The scientific ability and persuasive manner of the younger Brunel had a powerful influence in swaying public opinion favourably in the direction of schemes of which he was the engineer, and the Stephensons found the stoutest opponent to the project of a railroad through their native country in the person of their great rival. Brunel's design for an atmospheric railway through Northumberland met with large support from the landed proprietors of the shire, while Lord Howick, one of the members of Parliament for the county, entered with great zeal into the contest for the atmospheric principle and against the Locomotive.

In the Parliamentary session of 1845 these rival projects of the Stephensons and Brunel were debated with all the energy and ability that could be brought to bear upon the advocacy of each. Robert Stephenson and Brunel were both examined at great length as to the merits of their respective schemes; the latter engineer claiming for his own, as its chief recommendations, the qualities of rapidity, comfort, safety, and economy. But the issue was again in favour of the Locomotive, for the line and motive power for which the Stephensons had contended with their usual perseverance and determination were approved by Parliament, and the Bill in which they were interested received the Royal assent. When the news of the victory which had been again achieved for the Locomotive reached Newcastle, the townspeople made holiday over the event; while the workmen of the Stephenson factory, numbering upwards of eight hundred, turned out with band and banner to parade in procession the principal streets. But we must now glance at circumstances in connection with the progress of the railway system, the record of which forms, perhaps, one of the darkest pages in the history of English speculative enterprise.

The great railway mania of the years 1845–46 raged with disastrous effect among various classes of society. The epidemic was not confined to financial circles. While the reputedly rich succumbed to the fell influence of the malady, the comparatively poor became its unconscious victims. At least two periods of popular infatuation in regard to railway speculation, and from the same cause, had preceded the madness that infused itself throughout the community during the years in question. No former visitation of this species of mania, however, had proved half so virulent or devastating in its consequences.

In the year 1825 a sudden impulse had been given to the projection of railways on account of the measure of public confidence which had been excited in favour of the Stockton and Darlington line. When the success of the first public railroad had been assured, in the following year, not fewer than ten applications for powers to construct lines were successfully made to Parliament, while from 1827 to 1835 inclusive, forty-four similar Acts were passed by the Legislature. What has been termed the second era of railway madness ended with the year 1837, during which session only fifteen Bills were carried for new schemes, whereas, in 1836, not less than twenty-nine Acts, authorising the construction of lines, received the Royal assent. The years 1838 and 1839 were together only identified with the passing of five Acts of a like character, and the session of 1840 was signalised by its total want of any enactment for the formation of an entirely new line of railway.

The depression which had continued for three years in the railway world was not dissipated until another term of three years had allowed speculators to reap some benefit from the capital which had been already invested, and the country in general had been forced to acknowledge the great advantages which an extended railway system was calculated to confer. In 1844 speculation in new schemes

received an impetus that was not arrested until ruin, complete and overwhelming, had overtaken many who had started in the alluring race for wealth. That year was identified with the passing of Acts for the construction of forty-eight new lines; the gross length of which was over seven hundred miles, with an estimated expenditure of £14,793,994. Projectors, in prosecuting their schemes, did not now experience such difficulties as had confronted the early pioneers of the iron highway. Landlords had become the warmest advocates of the railway. Public opinion had set in favour of a mode of conveyance which ensured comparative speed, comfort, and economy. Parliamentary Committees did not now view with distrust or suspicion the testimony of witnesses for the promoters. Altogether, circumstances appeared to countenance the investment of capital in such undertakings, and to promise a rich reward to those who were fortunate enough to secure shares in such companies. But there were rogues as well as honest men to be enriched, and those who had no capital to invest in railway stock contrived to earn immediate dividends by devoting their wits to speculation in knavery. The ready traffic in letters of allotment offered special inducements to the unscrupulous to encourage and develop nefarious practices.

When the great railway madness was at its height, the trade of "letter-selling" was a brisk one. To the large number of impecunious scoundrels who embarked in it, the business had charms peculiarly its own. Its followers required no capital. An office for its transactions would have been a superfluity. The professional "letter-seller" was his own manager and messenger, secretary and servant. He conducted his own business and cleaned his own boots. Where he lived his boon companions did not know. He hated work direfully, but loved scheming intensely. The heading of such letters as were written by him in anticipa-

tion of a profitable answer usually contained the address of a suburban post-office, where return communications were kept till demanded by the letter-seller in person. The morning papers were early and carefully scrutinised at a cheap coffee-house, and notes taken of all places to be visited during each day, either for prospectuses of projected railway companies, or forms of application for shares therein. His meagre breakfast and full memoranda taken, the worthy sallied forth upon his mission of spoliation and deceit. First he called at the receiving-house for his letters. Were fate propitious, and he found that shares in some improbable railway scheme had been allotted to him, he proceeded without delay to one of his brethren in the letter-selling profession, who could command the few shillings necessary to purchase directly from the needy adventurer the official letter that announced the circumstance that a certain number of shares in a very uncertain project had been duly allocated to him as an applicant for the same. The first purchaser, in dealing with the second, took care to make a profit out of the transaction. And so the game went merrily on until the letter of allotment had changed hands several times, and upon each occasion at a profit to the seller. The worthy to whom the shares had been allotted had meanwhile not been idle. The first sale of the communication had given him a few shillings wherewith to meet the expenses of the day. With a light heart, for he had silver in his pocket, he had proceeded on his search after new prospectuses; and, just to break the monotony of his existence by varying the nature of his pursuits, he had called upon the promoter of a splendid project that, strange to say, had only required a few well-sounding names to launch it steadily upon the stream of fraudulent imposition. Names!—he would not have scrupled to write a hundred to order, at the low charge of five shillings each! But his precarious income was more securely derived from letter-selling, and he prosecuted that

questionable trade with an energy that would in all probability have secured for him in an honest calling a comfortable competency and an honourable reputation. Here, however, a question is suggested. How was it possible for such individuals to become the prospective shareholders in public companies? At the time of which we write nothing appears to have been easier.

A large proportion of the schemes were "brought out," to use a cant phrase of the period, without the slightest regard to public requirements, present or future. In too many instances "opposition lines" were projected for the sole purpose of putting money in the pockets of a few promoters, who devised such schemes in anticipation of "opposition" to other and sounder designs being "bought off," by the payment of an extortionate sum for the withdrawal of a contest. A needy attorney, with the aid of a few unscrupulous friends, could hatch a "bubble company," capable of fleecing a host of confiding shareholders, while levying a sort of black-mail upon the honest projectors of another association floated in good faith, and for the advantage of a district. As a matter of course, the lawyer attended to the legal business of the affair, while one of his brother knaves, without the slightest reference to education or training for the position, appeared as the "engineer of the company." A third conspirator agreed to accept the situation of "secretary," and the remainder of the confederacy were directors, with large fees paid to themselves out of the "deposits" paid by their dupes. Now the letter-sellers appeared upon the scene, and assisted in the conspiracy by disposing of share allotments at a premium. The following quaint description of that lower species of social harpy who turned an occasion of popular excitement to unprincipled profit, by making it an easy matter for greater rogues to prey upon the credulous and the unwary, is taken from the *Railway Register*, for June 1845:—

"In the first place rank the stags, outside men, third-class train, or stand-ups, as they are variously termed, and who follow this and other nefarious pursuits as a profession. Your stag is generally a man of some forty years or upwards, with a sinister expression, a face suggestive of strong drinks, and apparel of very indifferent appearance. Sometimes he disports a faded suit of black, sometimes drab trousers and gaiters, and he flatters himself that he has the appearance of a respectable business-like man. Occasionally he has the sharp eye and hooked chin of a shark; but, for the most part, he is scarcely distinguishable from his brethren in other disreputable pursuits; and you might take him for a job bail, a bumbailiff's follower, a hanger-on of the Insolvent's Court, a broker's man, or the messenger of a debtor's gaol. Some individuals of the species are more akin in appearance to sporting blackguards, and the profession generally have a taste for sporting. They indulge in small transactions on the Derby and St. Leger, do not eschew skittles, are constantly ready to play any game at cards, have a bet ever on their tongue; and if a stag have his hand in his pocket, he has generally got a greasy halfpenny in it, prepared for tossing up and deciding some of the frequent contests in which his veracity is called in question. This, however, is his easier mood; when sneaking into an office as a slate quarry proprietor, or great railway capitalist, he has a more subdued air, and the clerk in his teens, and first experience of railway business, listens to his inquiries with becoming deference, and ushers him into the presence of the secretary, or sees him carefully lay up the letter of application in his enormous pocket-book, to which his multifarious memoranda are consigned, and which contains a list of all the applications he has under hand, entered systematically, with the several names and addresses made use of. The clerk little thinks that the bulk in his coat pockets consists of several enormous bundles of prospectuses, greasy outside, and bound up with red tape."

But the sale of letters of allotment was not confined to the professional swindler. Amateur knaves frequently made a profit out of the practice. The writer proceeds:—

"Another class of letter-sellers consists of the loose young men about town of all classes; many of them having property, means, or connexions, but reckless of the consequences, and tempted by the profits. Many broken-down and junior physicians and barristers are among this tribe, and also half-pay officers of the army and navy. Numbers of clerks write for shares, and pretty generally sell the letters. Tradesmen also, if successful in their applications, sell the letters, and many

men of large property, and otherwise highly respectable, pursue this course. Tradesmen of a speculative turn, and about to fail, adopt share-writing as a subsidiary resource, though with the fears of the Court of Bankruptcy before their eyes, which is not very merciful to share-gambling. Servants write for shares in their masters' names, and there is a story afloat of a butler at the West End giving notice to his mistress to quit, as he had realised several thousand pounds by shares. On his mistress asking him how this was, 'Why, ma'am,' said he, 'I applies for the shares, and gives a reference here; and, as I opens the door myself and answers the reference, I always gives myself the wery highest character for property and all that, and so I gets the shares and sells them.'"

While it was true that allotment letters pertaining to the shares of respectable companies might be thus disposed of, it was to be lamented that facilities were given by the traffic to those who had evil designs towards the numerous class of fair and equitable speculators. Organs of the press, specially devoted to railway interests, contained advertisements of schemes, ostensibly of the most promising character. The subscription lists were found to be well filled with names. Quotations were given as to the number of shares subscribed, with the amount of deposit money held by the various projected companies, good, indifferent, or bad. Shares speedily rose to a premium, and unwary investors, fascinated by the glitter which surrounded the situation, and anxious to become the *bona fide* purchasers of stock, applied to the directors of "bubble companies." But when the merits of the fictitious projects came to be scrutinised by Parliamentary Committees, the Bills relating to these were thrown out, or dismissed, on account of intentional informalities on the part of the legal agents. In the meantime, however, the deposits made by the public, as well as the sums mulcted by the letter-sellers, were irretrievably lost to the honest investors, and served to enrich the coteries of scoundrels who had started associations for their own personal and unscrupulous ends. In more than one instance

a company, its registered office, board, and agents, were found to have suddenly disappeared from the scene, leaving the too-trustful shareholders to find out, as best they might, the humiliating facts that the office had merely been hired by the week, and the so-called directors had been but the paid tools of financial schemers in the city of London.

As we have seen, Acts were passed by Parliament in the year 1844 authorising the construction of forty-eight new lines, at an expenditure estimated under £15,000,000. In 1845 permission was granted by the Legislature for the formation of one hundred and twenty fresh undertakings, with 2883 of a total mileage, and at an entire cost computed at nearly £44,000,000. In the year following, an expenditure of £121,500,000 was sanctioned for the making of two hundred and seventy-two new railroads, the lengths of which extended to the enormous aggregate of 4790 miles! Instances furnished by Robert Stephenson himself go far to show how railway legislation was at that period conducted. Speaking in his capacity as President of the Institute of Civil Engineers, in the year 1856, he said:—

"The ingenuity of man could scarcely devise a system more easy than that of getting a railway Bill through the Legislature. But who devised that system?—Parliament itself. Who have begged and prayed, and implored for alteration unavailingly?—directors and officers of companies. An illustration may show more graphically how Parliament has entailed expense upon railway companies by the system it has set up. Here is a striking one. The Trent Valley Railway was, under other titles, originally proposed in the year 1836. It was however thrown out by the Standing Orders Committee, in consequence of a barn, of the value of about £10, which was shown upon the general plan, not having been exhibited upon an enlarged sheet. In 1840 the line went again before Parliament. It was proposed by the Grand Junction Railway Company, now part of the North-Western. No less than four hundred and fifty allegations were made against it before the Standing Orders Committee. The Sub-Committee was engaged twenty-two days in considering those objections. They ultimately reported that four or five of the allegations were proved; but the Standing Orders Committee, nevertheless, allowed the Bill to be

proceeded with. Upon the second reading it was supported by Sir Robert Peel, and had a large majority in its favour. It then went into Committee. The Committee took sixty-three days to consider it, and ultimately Parliament was prorogued before the report could be read. Such were the delays and consequent expenses which the forms of the house occasioned in this case, that it may be doubted if the ultimate cost of constructing the whole line was very much more than the amount expended in obtaining permission from Parliament to make it.

"This example will show the delays and difficulties with which Parliament surrounds railway legislation. Another instance will illustrate the tendency of its proceedings to encourage competition. In 1845 a Bill for a line now existing went before Parliament with no less than eighteen competitors, each party relying on the wisdom of Parliament to allow their Bill at least to pass a second reading! Judged by such a case, the policy of Parliament would really seem to be to put the public to expense, and to make costs for lawyers and fees for officers. Is it possible to conceive anything more monstrous than to condemn nineteen different parties to one scene of contentious litigation? Bear in mind that every additional Bill received by Parliament entailed additional expense, not only on the promoters of that one Bill, but on all the other eighteen competitors. They each and all had to bear the costs, not of Parliamentary proceedings upon one Bill, but of the Parliamentary proceedings on nineteen Bills. They had to pay not only the costs of promoting their own line, but also the costs of opposing eighteen other lines. And yet, conscious as Government must have been of this fact, Parliament deliberately abandoned the only step it ever took, on any occasion, of subjecting railway projects to investigation by a preliminary tribunal."

When the great mania for railway speculation had passed away, it was found that many had been reduced to beggary by the infatuation which had seized them. Professional schemers, rogues in disguise, had in the main, however, fattened well upon the opportunities offered for engaging in lucrative rascality with impunity. Eminent or favourite Parliamentary counsel and agents also participated in the good things which the mania brought to those who had brain-power or ability to dedicate to the service of the railway system. Of all those who were called upon to engage prominently in the arena of contention and turmoil,

no class of men worked harder for legitimate professional fees than that of the railway engineers. As the success of a projected scheme frequently depended entirely, or nearly so, upon the reputation of the engineer who had been called to give evidence in its favour before a Committee, so the services of distinguished members of the profession were in urgent request when the intentions of the promoters were strictly in accordance with the professions declared in their application for Parliamentary powers. When the case stood otherwise, engineers who had a reputation to lose invariably rejected the proffered bribe, by which the unscrupulous had sought to enlist high advocacy on behalf of a delusive project, or had endeavoured to attract to the same the favourable influence attached to an honourable name. Robert Stephenson would never give evidence contrary to his conscientious belief. It is related that he and his friend, Mr. Bidder, received by post one morning cheques to an amount exceeding £1000. These had been forwarded by the promoters of various companies, but without any previous notification that the services of the engineers would be required in return. The bribes, however, were speedily sent back to those who had forwarded the tempting considerations, with the stinging intimation in each case that the evidence of Robert Stephenson, or his friend, could neither be bought nor sold.

CHAPTER VII.

ROBERT STEPHENSON'S BRIDGES.

THE "Battle of the Gauges" presented the unusual spectacle of a stirring contest, with the leaders of the two opposing forces knit together by the ties of a common and enduring friendship. Very rarely have two adversaries been found of stouter qualities in the prosecution of their cause, or of nobler bearing towards each other as antagonists, than Robert Stephenson and Isambard Kingdom Brunel. Often called upon to meet the force of each other's opposition, the engineers never allowed professional rivalry or personal interests to dull the keenness of their mutual regard. When one was beset by a gigantic difficulty, he could rest with confidence upon the intense sympathy and ready help of his generous rival. But each found the other a stern and searching critic of his theories and his plans. To that fact may be attributed, in some measure at least, the high reputation which both attained.

The gauge of 4 feet 8½ inches fixed upon by George Stephenson for the Stockton and Darlington line, and adopted generally for other railways, had been the gauge of the old tramroads of the North. Brunel's ideas, however, were not to be confined within the sphere of usage or con-

venience, and he boldly challenged the utility of keeping to the "narrow gauge" of the early waggonways and public railroads. His appointment as engineer of the Great Western line enabled Brunel to put his theory of a broad gauge of 7 feet to a practical test, as the directors of that railway soon found all their prejudices in favour of a more economical iron road swept away by the persuasive powers of their engineer-in-chief, who declared that the adoption of his views would ensure greater speed and comfort in travelling, combined with proportionately less charges for working the line. We need not recall the arguments used by the contestants when the controversy was at a height. It is sufficient here to state that the merits of the several gauges —"narrow," "broad," "double," "mixed"—were scrutinised by a Royal Commission, appointed in 1845 to ascertain "whether, in future private Acts for the construction of railways, provision ought to be made for securing a uniform gauge; and whether it would be expedient and practicable to take measures to bring railways already constructed, or in progress of construction, into uniformity of gauge." The Commission of inquiry was followed, in August 1846, by an Act making it unlawful to construct any new railway of a wider gauge than 4 feet 8½ inches in Great Britain, and 5 feet 3 inches in Ireland. The chief principle of that enactment had been earnestly contended for by Robert Stephenson, whose colossal bridges must now succinctly engage our attention.

The name of this famous engineer will go down to posterity as that of the designer of some of the largest bridges in the world. His finest structures of the kind have the peculiarity of being extensively composed of iron. Bridges of that material were first erected in this country, and although foreigners had attempted to use the metal for such a purpose, even before Englishmen had done so, it was not until our countrymen had developed the principle to some extent that

Continental engineers adopted it, except in a few isolated cases. The introduction of railways naturally forced upon the attention of their constructors the question of spanning rivers and chasms with bridges, in which should be combined sufficient durability and strength with speediness and economy in erection. In some situations the simple arch of stone or brickwork could be adopted with advantage; but such structures would have involved occasionally an excessive outlay without a commensurate benefit in return. Besides, the use of iron enabled engineers to give elegance as well as efficiency to a railway bridge, when the position called for tasteful design in the special form or general appearance of the work. It is not our purpose, however, to enter into the *minutiæ* of bridge-building, but rather to give a faint outline of the more remarkable bridges with which the name of Robert Stephenson is identified.

About the year 1838, the route of the Chester and Holyhead Railway was surveyed by George Stephenson, but it was not until the line had been resurveyed by his son, and an Act obtained in 1844, that the construction of its 84½ miles of iron highway was proceeded with vigorously. The making of this railroad presented to Robert Stephenson, the engineer-in-chief, difficulties of considerable magnitude. Leaving a tunnel at the city of Chester, the line was carried over a viaduct of forty-five arches to the river Dee, which was spanned by an iron bridge. The channel of the river and its estuary was then followed till the shore of the Irish Sea was reached. Then the railway appeared along the coast, with important engineering works marking its course. Avoiding the Great and Little Orme's Head, the narrow valley separating these headlands from the mainland was passed through, and the river Conway crossed by an iron tubular bridge of a single span 400 feet in length. This structure was of considerable consequence to the engineer, as it gave an opportunity for putting his tubular principle to such a test

as enabled him to gather data for the foundation of greater works of the same description, while it confirmed his conclusions as to the feasibility of throwing a bridge upon that principle across the Menai Straits; a task that Robert Stephenson then had on hand at another part of the line.

The Britannia Bridge was designed to connect the mainland of Carnarvonshire and the island of Anglesea by a railway, so as to ensure speedy communication between England and Ireland: the port of Holyhead offering special advantages as a landing-stage for steamers crossing the Irish Channel to and from Kingston. At first it had been intended by the promoters to use for the purpose Mr. Telford's magnificent suspension bridge, by appropriating one of its two roadways to the railway. The Government, however, refused its sanction to the scheme, and the company instructed the engineer to proceed with the necessary survey previous to constructing a railway bridge over the Straits. Robert Stephenson selected, as the most suitable place for crossing, a point situated about a mile westward from Telford's structure. The circumstance that mainly influenced the choice of the engineer was the presence of an island called the Britannia Rock, in the middle of the stream, which he purposed to utilise as a foundation for the central pier of a bridge with two cast-iron arches, each of which was to be 350 feet in the span, with a versed sine of 50 feet. The roadway was to be 105 feet above high-water at spring tides. To that plan of an arched bridge, however, the Admiralty, as the guardian of the Navigation, gave so much opposition that it was abandoned; and eventually the idea of a tubular bridge offered to the engineer an escape from the difficulty, as each opening of such a structure would be of uniform height throughout, and consequently present no interruption to the safe navigation of ships in their passage under the bridge. Robert Stephenson's designs having been, after due consideration, approved by

the authorities, the construction of the great tubes was proceeded with near the spot where the heavy masonry necessary for their support had begun to be reared; the operations being under the absorbing attention of the engineer-in-chief.

Nearly a million-and-a-half cubic feet of masonry was required in the formation of this noble specimen of engineering work. The central tower is 230 feet high; the two others are each eighteen feet lower than that on the Britannia Rock. The two tubular beams through which the lines of rail pass are each 1511 feet long. The apparently excessive height of the towers is due to the fact that the hydraulic presses, used for raising the ponderous tubes into their places, required to be fixed in position by extending the towers considerably above the line which the tubes would describe when the bridge was completed. The abutment at each end of the bridge is thirty-five feet lower than the side towers. The exterior of the masonry is faced with Anglesea marble: the interior portion is of brickwork and sandstone. While exception may be taken to the architectural peculiarities of this bridge by the critical beholder, the massive greatness of its proportions impress the mind with feelings of wonder at the daring character of the undertaking. The total weight of ironwork was 11,468 tons. The rivets used in the tubes exceeded 2,000,000 in number. The entire cost of the structure was a little over £600,000, and time has amply verified the calculations of Robert Stephenson as to its thorough stability, as well as the marked efficiency of the tubular principle when employed on a colossal scale. The formation of the Chester and Holyhead Railway was not an unalloyed triumph, however, for we must now advert to a matter connected with its history which cast a temporary shade over the reputation of its engineer.

On the 24th of May 1847, a serious accident occurred on

the Dee Bridge, by which that construction was partially destroyed, and five persons lost their lives. On that day, a quantity of broken stones had been laid upon the wooden platform of the bridge as a protection against fire from the dropping of red-hot cinders by the locomotives. The first passenger train that reached the structure after the stones were laid was that with which the calamity was associated. The width of the Dee at the point in question is about 250 feet, and the railway is elevated about forty feet above the level of the river at low-water. The bridge was divided into three openings, with iron girders of a clear span of ninety-eight feet each. On the 20th October 1846, the work had been examined and approved by the Government Inspector, and up till the hour of the calamity traffic had been continued without any apprehensions having been entertained as to the stability of the bridge. The engine of the fatal train, which had just left Chester, had reached the last opening of the structure when one of the girders broke into three pieces, and the carriages were precipitated into the river, a depth of thirty-six feet. A lengthened inquiry took place before a coroner and jury as to the cause of the accident; other engineers as well as Robert Stephenson being called to give evidence. In the result, the jury coupled to their verdict of accidental death an opinion that the broken girder had not been sufficiently strong to bear the pressure of quick trains; that they considered the bridge unsafe; and that, for the security of passengers, a Governmental inquiry should be instituted, with a view to guard against a recurrence of such accidents. The propriety of such a finding was disputed at the time, and it is questionable whether the true cause of the failure was clearly established. Still, the incident is but one of the many experiences which add force to the thought that it is not within the power of the most gifted men always to command undeviating success for their enterprises. But we

must now glance at one of the most successful engineering works of modern times.

The High Level Bridge across the Tyne, at Newcastle, is a noble monument to the genius of its designer. Perhaps of all his stupendous bridges it is the most important in the result which it effected; for it not only supplied a pressing local want in affording easy communication between the towns which its platforms united, but it welded a broken link that would otherwise have existed in the great chain of railways that now stretches from the Metropolis to Scotland. At the crossing point the river runs through a deep valley, the sides of which are covered by the streets and buildings of Newcastle and Gateshead. Formerly, the only expedient for connecting at the Tyne the northern and southern highways of the country was by means of the "Old Bridge," which crossed the river at a low level ninety yards eastward from Robert Stephenson's grand structure. The antiquated construction has within the last few years given place to a "Swing Bridge," that allows ships of large tonnage to pass through its portals. The growing requirements of the district, however, demanded additional facilities for traffic, and as early as 1825 a scheme was projected for connecting the two boroughs by a bridge at such a level as would obviate the necessity of using the steep incline on either of the banks.

Owing to the want of public spirit in the communities for whose benefit such a construction had been contemplated, the project was abandoned. Subsequent schemes of a similar character shared also the same fate until, in 1843, the matter was again taken up by local gentlemen, led by the late Mr. John Hodgson Hinde. In the prospectus which was then drawn up of the "High Level Bridge Company," the name of George Stephenson appeared as that of a director, while his son was designated the consulting engineer to the promoters. The project was held in abeyance, how-

ever, until the more important one of a railway across the Tyne had been decided upon, when the two schemes were practically merged into one. Accordingly, George Stephenson's design for a railway from Newcastle to Berwick comprehended a union of that line, by means of a high level bridge, with the Newcastle and Darlington railroad, the northern terminus of which was at Gateshead. Some idea may be formed of the importance which was attached to the project of a high level railway over the river, by the statement that previous to its completion the enormous sum of £1000 was expended weekly by the public in the conveyance of passengers and merchandise between the termini of the two lines.

At the point crossed the Tyne is 512 feet wide at high-water; but, as the structure stretches over the sloping banks, considerable addition is made to the distance over the waterway, the total length of the bridge being 1372 feet. Six large openings, each with a span of 125 feet, stretch over the river and its embankments; and the abutments are formed by arches, which carry the railway over the sloping sides of the ravine. The first large opening on the south stretches over a narrow riverside lane, called Pipewellgate, where it is alleged Daniel Defoe wrote the immortal story of *Robinson Crusoe.* The piers of the "High Level" are built of a durable description of sandstone found in the neighbourhood, and some of the piers are 146 feet in height from the piles that form their foundation. Many of the piles were driven nearly forty feet into the bed of the river, until a solid footing was found on the rock beneath. A space of three feet, filled with concrete, separates each pile from the next in the same pier. About two feet under the level of low-water begins the masonry, the lower portions of which are provided with cutwaters. The surface of the foundation of each pier is about 76½ by 22½ feet. The section of the tall shaft of each pier is about

forty-six by fourteen feet, and is lightened by an arched opening twelve feet wide. It was computed that each pile would not be required to sustain a weight of seventy tons; but, with his usual caution, Robert Stephenson caused one of the piles to be tested, after it had been driven home, by laying upon it a weight of 150 tons. On the removal of the load, after an elapse of several days, it was found that no further settlement had occurred. The total quantity of masonry is 686,000 cubic feet, and the iron-work of the superstructure weighed 5050 tons. The upper platform, carrying three lines of rails, is 120 feet above the river at low-water; the lower, on which are the footpaths and carriageway, is about twenty-three feet below the railway. The cost of the entire work was £243,000, and the opening of the bridge was an event that gave occasion for much local rejoicing—the inaugural ceremony, on the 27th September 1849, being performed under the auspices of Her Majesty the Queen.

The drawings for the construction of the High Level Bridge were prepared, under the direction of the engineer-in-chief, by Mr. Thomas E. Harrison, who now fills the position of consulting engineer of that important railway system which absorbed the Newcastle and Berwick Railway, namely the North Eastern. Speaking at a banquet given in his honour at the New Central Station, Newcastle-on-Tyne, on the 30th July 1850, Robert Stephenson acknowledged the great value of the services which had been rendered by his assistant in the huge undertaking.

Another work by this famous engineer that deserves notice is the railway viaduct known as the Royal Border Bridge, at Berwick-on-Tweed. Its greatest height from the bed of the river is 126 feet, and it is built, above the water, of ashlar, with a hearting of rubble; the piers being constructed with bricks and cement. The bridge is formed of twenty-eight arches, each with a span of 61½ feet, and the

total length is 2160 feet. Altogether it is an important structure, and reflects credit upon its designer and builders. But all Robert Stephenson's bridges appear dwarfed when compared with one of the last reared from his plans. The Victoria Bridge over the St. Lawrence, at Montreal, is five times longer than the Britannia over the Menai Straits, but is akin to it in being likewise on the tubular principle. It is divided into twenty-five spans; the great central one being 330 feet, and each of the others 242 feet. The railway is carried within the tubes sixty feet above a river which brings down from its higher reaches in spring immense blocks of ice that threaten to sweep away everything that would appear to bar their progress. But the massive piers are solid and stable, for they unitedly bear, in the iron tubes alone, a weight little short of ten thousand tons. The first stone of the piers was laid on the 22nd of July 1854, and the works were carried on without interruption during the space of five and a-half years. On the 19th of December 1859, the structure was opened for traffic, but the formal inauguration of the Victoria Bridge did not take place till the 25th of August 1860, when the Prince of Wales, who had visited Canada specially for the purpose, honoured the important occasion by his presence. The rejoicing with which the Canadians hailed the event, however, was tinged with the sadness of the thought that death had deprived Robert Stephenson of the pleasure of witnessing the successful completion of one of his greatest undertakings.

CHAPTER VIII.

THE MEMBER FOR WHITBY.

AT the General Election of 1847, an invitation was sent from the electors of Whitby to Robert Stephenson, in order to secure his services as member of Parliament for that borough. Politicians of every shade of opinion waived their differences in order to further the return of the eminent engineer. This mark of confidence from a section of his countrymen touched him deeply, coming as it did at a time when his reputation had not recovered from the shock which it had received by the failure of one of his structures, the Dee Bridge, and the reflections upon his skill which that disaster had occasioned. On the 30th of July 1847, he was returned for that constituency without opposition, and in due course took his seat in the House of Commons; an honour which he retained unto the day of his death. At the same period, it may be remarked, George Stephenson was asked to solicit a similar distinction at the hands of the electors of South Shields, by becoming a candidate for their suffrages. The position was, however, respectfully refused. "Politics," the elder Stephenson used to say, "have no stability—they shift about like the sand of the sea—they are all matters of fancy, matters

of theory, and I should feel out of my element amongst them." Upon one political doctrine only had he any very decided opinion, namely that of Free Trade. "England is and must be a shopkeeper," said the father of the railway system on one occasion, "and our docks and harbours are only so many wholesale shops, the doors of which should always be kept wide open." His son, throughout his Parliamentary career, did not follow the parental dictum in that particular at least, for the member for Whitby was a Protectionist of the most rigid and uncompromising school.

Robert Stephenson had been conservative, or rather a Tory, from his childhood, and his residence in South America had the effect of strengthening his already decided prejudices in favour of a constitutional monarchy. Nor is this to be wondered at, when we consider that the worst phases of a Republican system of government had been presented to his view during his stay in Columbia. There the bribe, the pistol, and the dagger constituted the most convincing forms of political argument. Venality in the rich, and servility among the poor, were the prominent characteristics of the two classes of society. Officialism and corruption went hand in hand. The most degrading vices inherent to a despotic government were not only practised by the champions of popular opinions, but in too many instances these were openly and unblushingly defended by the so-called leaders of political thought. Possibly the revolution which had established Republicanism in the country may have found, but not created, the abominable system which the engineer deplored. Be that as it might, the Columbian Government, during Robert Stephenson's sojourn under its rule, took no steps to reform the abuses which prevailed, to the discredit of a Republican administration and the moral degradation of the people. The engineer had returned from America with highly conservative views as to political matters in general, and these he retained throughout his life.

Little more than a year after his first election for Whitby, Robert Stephenson lost his father, and the blow which death had inflicted was, to the devoted son, a terrible one. The two famous engineers had been to each other more than father and child. They had been professionally and intimately associated. Together they had fought the Battle of the Locomotive. They had jointly participated in the honours and rewards accorded to the victors in the triumph of the railway system. The feelings of the engineer, as he stood beside the open vault at Trinity Church, Chesterfield, that was about to receive the remains of his parent, were only experienced by him upon two occasions during his lifetime. The other was when Robert Stephenson committed the body of his wife to the grave at Hampstead.

Although precluded by his numerous engagements from giving regular attendance at the House of Commons, he never abstained from taking part in debates when the claims of his profession permitted him to do so, and he considered that his judgment or engineering knowledge might be of service to his countrymen. His maiden speech was delivered in favour of the proposal for an International Exhibition, and against a counter-motion by Colonel Sibthorp. The member for Whitby was on the Committee appointed for raising a building suitable for the purpose of a Great Exhibition, and the Crystal Palace in Hydē Park had not a more faithful advocate or friend than Robert Stephenson; indeed, he lent to that enterprise, the forerunner of its kind, all the weight of his great ability and vast influence.

In the year 1852, a dissolution of Parliament enabled the engineer to test the feeling of the Whitby electors in regard to their representative. Upon seeking re-election, he was opposed by the Hon. Edmund Phipps, but again returned; the majority in his favour being about two to one. We select the following speeches of Robert Stephenson, not

only because these were, perhaps, the most important of his Parliamentary utterances, but on account of the bearing these have upon a question which excited a prominent degree of interest at the time, and which subsequently called forth some severe strictures on the part taken by the member for Whitby in the controversy. The revived scheme for the construction of a canal across the Isthmus of Suez met with considerable opposition on this side of the English Channel, and it is not too much to say that the adverse opinion of our engineer regarding the project did much to prejudice the minds of Englishmen against it, and to retard the efforts of its promoters.

On the 17th July 1857, the following question was put to the Commons by a member:—"Whether, in their deliberate opinion, it be conducive to the honour or the interests of this country that we should manifest and avow the existence of a jealous hostility on our part to the project of a ship canal through the Isthmus of Suez?" Lord Palmerston, in reply, recapitulated the political objections to the scheme, and condemned it as "one which no Englishman with his eyes open would think it desirable to encourage." The Foreign Secretary concluded a telling address against the project in the following words:—"I take leave to affirm, upon pretty good authority, that this plan cannot be accomplished, except at an expense which would preclude its being a remunerative undertaking; and I therefore think I am not much out of the way in stating this to be one of the bubble schemes which are often set on foot to induce English capitalists to embark their money upon enterprises which, in the end, will only leave them poorer, whomever else they may make richer." Robert Stephenson then rose and gave his reasons for opposing the projected undertaking, as follows:—

"I will not venture to enter on the political bearings of the subject with respect to the other Powers of Europe, but will confine myself

merely to the engineering capabilities of the scheme. I have travelled partly on foot over the country to which the project applies, and have watched with great interest the progress that has been made by various parties in examining the question. I first investigated the subject in 1847, in conjunction with M. Paulin Talabot, a French engineer, and M. de Negrelli, an Austrian engineer. At the suggestion of Linant Bey, a French engineer, who has been upwards of twenty years resident in Egypt, and feeling how important is the establishment, if possible, of a communication between the Red Sea and the Mediterranean, I have qualified myself to form an opinion on the subject. It has been received, on the authority of an investigation of the levels taken by the French engineers during the invasion of Egypt about 1800 that, as stated by the ancient writers, there was a difference between the levels of the Mediterranean and the Red Sea of something like thirty-two feet. It was suggested at that time that the old canal might be opened out again, and that a current might be established between the Mediterranean and the Red Sea of from two to three miles an hour, which velocity of water would not impede the communication between the Mediterranean and the Red Sea, as steam-tugs might be employed, and the canal might at the same time be kept perfectly open, as the scouring power would be adequate to maintain a clear channel. I went into this scheme under the belief that that difference in the level did actually exist. The examination was made by myself and the gentlemen with whom I was associated in 1847. We had not any idea, at that time, that if there was no difference of level it would be practicable for a canal to be made in the first instance, or that it could be maintained afterwards. After investigation, however, it was found that, instead of a difference of thirty-two feet, there is no difference of level whatever at the period of low-water, although for a period of fifty years the world has been under the impression, from the published statements and levellings of M. Lepère, that a difference of thirty-two feet existed. While it was supposed to exist, it was believed by professional men that a canal might be maintained, or that, as it was called, a new Bosphorus might be formed between the Red Sea and the Mediterranean. But when the difference of level was found to be *nil*, the engineers with whom I was associated abandoned the project altogether, and I believe justly; and one of them—M. Paulin Talabot—made an adverse report, which was published in the *Revue des deux Mondes* of May 1855. Since then I have travelled over the Isthmus to Suez, and over other parts of the Desert, and have investigated the feasibility of making a free communication between the two seas, on the supposition that they are upon the same level; as, for instance,

from the Nile. I may say, however, without entering into professional detail, that I have arrived at the conclusion that it is—I will not say absurd, because engineers whose opinions I respect have been to the spot since, and have declared the thing to be possible—at all events, if feasible (as the First Lord of the Treasury has said, money will overcome every difficulty), yet, commercially speaking, I frankly declare it to be an impracticable scheme. What its political import may be I cannot say, but as an engineer I would pronounce it to be an undesirable scheme, in a commercial point of view, and that the railway—now nearly completed—will, as far as concerns India and postal arrangements, be more expeditious, more certain, and more economical than even if there was this new Bosphorus between the Red Sea and the Mediterranean."

Nearly eleven months after the delivery of that speech, the member for Whitby was even more emphatic in his denunciation of the Suez Canal scheme. On the 1st of June 1858, Mr. Roebuck, M.P. for Sheffield, moved in effect that British influence should not be used to induce the Sultan of Turkey to withhold his assent to the project. The motion was seconded by Mr. Milner Gibson. In opposing it, Mr. Stephenson finished a short but telling address, on the engineering and commercial phases of the question, in the following words:—

"As far as the English engineers are concerned, I believe they all agree with me to a man. With respect to the difficulties in the way of carrying out the scheme, I will only point to the difficulty of cutting a canal through a desert, with no fruits, no fresh water to be found within that space. I have travelled on foot the whole distance, at least over all the dry land, and consequently feel justified in what I state. I do not desire to enter upon the political part of the question, but I can assert that, as far as the transit of passengers and mails is concerned, the proposed scheme would be productive of no saving of time in our intercourse with the East, for while they can be conveyed from Alexandria to Suez by railway in eight hours, it would require, even if the most perfect canal possible were constructed, at least double that time for vessels going to India to pass through it, for vessels must coal either at Alexandria or Suez. It is said that we have nothing to do with the physical difficulties of the scheme; but I think the House has something to do with them, or at least I have. If I had sat silent, it

would be said I had acquiesced in the motion, and had tacitly admitted that the Suez Canal was a feasible project ; whereas my opinion is that, if it is attempted at all, which I hope it will not be—or, at least, I trust it will not be with English money—it will prove an abortive scheme, ruinous to its constructors."

On the 18th of June 1858, M. de Negrelli, the Austrian engineer, published in the *Gazette* of his country a letter in reply to Stephenson's strictures in the House of Commons. In that communication a reflection was cast upon the honour of the distinguished Englishman by his Austrian *confrere*, which exhibited an acerbity of feeling, on the part of the latter, unwarranted by the actual facts of the case. M. de Negrelli said :—

"It is true that Mr. Stephenson went into Egypt without consulting his colleagues, not on the subject of the canal, but with the intention of entering into a negotiation with the Government on the subject of executing a railway from Alexandria to Suez. On this occasion, Mr. Stephenson may have traversed the Desert between Cairo and Suez ; but, if so, he can only have seen that part of the Isthmus which is near to Suez. However, our honourable friend pretends to have traversed on foot the whole Isthmus between the two seas. But in Egypt, where the preparations for a journey in the Desert always attract attention, no one has ever heard of this journey of Mr. Stephenson ; and his last assertion in the English Parliament, in which he stated that it would be necessary to dig eighty English miles, confirms the general opinion in Egypt that Mr. Stephenson has never seen, nor traversed the Isthmus, properly so called, as in that case he would have observed the basins of the Bitter Lakes and Lake Timsah, which will not have to be excavated, and which lessen by a considerable number of miles the number stated by Mr. Stephenson, as well as facilitate the execution of the canal in a considerable manner."

In reply to the charges thus deliberately and publicly made, the English engineer sent to the Editor of the *Austrian Gazette* a long and forceful letter, in which he gave a *resumé* of his connection with the original survey, and explained the circumstances of his private journey in question to the neighbourhood of the proposed canal. He wrote :—

"You will here permit me to mention a personal matter which M.

de Negrelli has elevated into importance. In the autumn of 1850, fatigued by the labours of an arduous year, I sought health and recreation in a yacht voyage to the Mediterranean. Arrived at Alexandria, I determined to make a personal investigation of the district in which, four years previously, I had been so deeply interested. Proceeding from Cairo by the usual route to Suez, accompanied for some distance by Captain Lindquist, then the agent of the Peninsular and Oriental Steam Company, I turned thence northwards into the desert, visited the site of the Bitter Lakes (now dry and desolate), encamped for two days at Lake Timsah, and from thence proceeded over the high ground towards Lake Ballah, travelling on foot, as indeed it is difficult to traverse otherwise a large portion of the deserts. From that ridge of comparatively elevated ground I was enabled to overlook the district towards Lake Menzaleh, which, during the period of high Nile, becomes a shallow lagoon, stretching along the coast and far into the desert. Then returning westward, I entered the Ouadee Toumilat, at Sababiar, and following the course of the ancient canal, I travelled in the direction of Bulbies and of the ruins of the ancient Bubastis, visiting the higher grounds to the north, and thence returning to Cairo. Altogether I spent fifteen or sixteen days in the district, and all that I saw and ascertained on this expedition confirmed my convictions as to the Suez Canal project, and the finality of M. Talabot's report. On my return to England I gave, on the 20th of May 1851, an account of this expedition in the course of a discussion on a paper read at the Institution of Civil Engineers, stating emphatically the opinion at which I had arrived, 'that it was evident that it would not be practicable to keep open a level cut, or canal without any current, between the two seas, and that the project was abandoned.'

"A report of my speech on that occasion will be found in the published *Minutes of the Proceedings of the Institution of Civil Engineers* (vol. x., pp. 10-13), a book which M. de Negrelli may find in the public libraries of Vienna. The circumstances of my expedition, though made without any ostentation, are well known both in England and in Egypt. I am astonished, therefore, at what I must call the audacious assurance with which M. de Negrelli insinuates in his letter: first, that I have never been in the locality at all; then, that if I have, I 'can only have seen that part of the Isthmus which is near to Suez.' 'Our honourable friend,' he writes, '*pretends* to have traversed on foot the whole Isthmus between the two seas. But in Egypt, where the preparations for a journey in the Desert always attract attention, no one has ever heard of this journey of Mr. Stephenson.' I must be permitted to tell M. de Negrelli that the sense of honour which prevails

in England forbids our presuming to doubt the word of a gentleman, without having at least some ground for suspicion; and that when, without foundation, he insinuates that I would be base enough, before the institution of which I have been president, and, seven years after, before the Commons of England, of which I am a member, to make statements as deliberately false as ridiculously objectless, he is attributing to me a course of conduct utterly unknown to his 'honourable friend.'"

During that visit to the desert, undertaken with a view to recruit his health, which had been shattered by arduous mental labour, Robert Stephenson collected a number of geological specimens, which were consigned to the interesting museum of natural history that adorned the cabin of his yacht. Through the destruction of that vessel by fire at Cowes, in the year 1851, the collection was lost, and the engineer took the first opportunity which presented itself of making good that portion belonging to the ground over which he had travelled in the Isthmus of Suez. Being at Cairo, in the winter of 1854, he went as far as the Bitter Lakes, under the escort of a Cavass of the Pacha of Egypt, and accompanied by Mr. Ayrton, an English resident of Cairo. "On this occasion," Robert Stephenson writes, "I pursued the same route with little variation; renewing my acquaintance with the physical features of the country, and still further confirming my views as to the soundness of M. Talabot's report." The writer then proceeds to give what appeared to him a weighty reason for continuing his opposition to the scheme; and however much one may regret the error in judgment which was committed by an eminent engineer—an error which dimmed the lustre of his reputation in the eyes of many of his countrymen—we cannot but admire the motives which actuated him in the course he pursued, namely, to shield Englishmen from the consequences of what he believed conscientiously to be a ruinous enterprise. In his communication to the *Austrian Gazette*, the writer continues as follows:—

"It was, I believe, in the year following this expedition—1855—that certain gentlemen waited on me in London and proposed to re-open the scheme for a Canal across the Isthmus of Suez. They had no new facts to offer to my consideration, and, in all that they stated, I found nothing that engaged any share of my confidence, or that in any way changed my views as to M. Talabot's report and the character of the project. *In dealing with the multitude of schemes from time to time submitted to me, I have uniformly declined to allow my name to be associated with any plan involving the subscriptions of my fellow-countrymen, for which I did not see good prospect of success. Acting on this principle, and feeling that the Suez Canal project, on such foundations, was not a sound undertaking, I declined to be in any way connected with the scheme.* I communicated this resolution to the promoters civilly and courteously. I know not why my persistence in it has given them so much offence. For some years past, however, I have been pursued by these parties, in their hired organs, with weekly attacks on both my personal and professional character. As I have said before, I have thought it most dignified to leave such attacks unnoticed: knowing whence they proceeded, indeed they appeared beneath notice. Under no circumstances will they ever engage my attention ; and it is only when I find a former colleague leagued with my assailants that it appears to me to be necessary to correct his misstatements."

That Robert Stephenson had some reason for feeling aggrieved at M. de Negrelli's attack is clearly shown in the fact that the Austrian engineer had tacitly concurred in the accuracy of the Report issued by his French coadjutor, M. Talabot, and had allowed "nine long years" to elapse, from the time of that Report being published, before he took steps to enlighten the world as to any adverse opinion he may have entertained regarding the views of the French and English engineers with whom he had been associated in the preliminary survey. Though time may have falsified the fears and predictions of our countryman as to the soundness of the scheme of a Suez Canal, we cannot but appreciate and admire the motives which actuated him in his opposition to a proposal that was involved in considerable doubt and uncertainty.

Robert Stephenson was chosen in 1855, by his profes-

sional brethren, as President of the Institution of Civil Engineers, and he filled the office during two years. On the 25th of June 1857, he received the honorary degree of D.C.L. of Oxford. Both marks of distinction, however, came to him at a time when failing health prevented the great engineer from setting a value upon personal honours, although he continued to the close of his life to be keenly sensitive to acts of kindness or tokens of regard on the part of his friends and acquaintances. His physical powers were now irreparably shattered. From 1850 until a short time before his decease, he read books on a great variety of subjects; his yacht having an excellent library provided for the mental recreation of her owner when at sea. When at home, during the closing years of his life, he often perambulated the apartments, and gave vent to the sorrow which oppressed him by the consideration of his loneliness. The thought of his early triumphs and present honours only served to deepen his regrets that the only woman he had ever loved had been taken from his side, and no child of theirs would inherit his name and wealth.

On the 21st of August 1859, he arrived at Christiania, in order to be present at a banquet given to his honour, and in celebration of the opening of the Norwegian Railway, of which he had been the consulting engineer. On the return trip, the friends who accompanied him in the "Titania" and another yacht became painfully anxious on account of his prostrate condition, fearing that he would die before reaching England. He rallied, however, and arrived at his residence in Gloucester Square, London, where he expired on the 12th of October 1859; the immediate cause of death being jaundice in an aggravated form, followed by dropsy of the whole system. The departure of Robert Stephenson from the scene of his engineering triumphs was felt to be more than a national loss, for other countries besides his own had claimed the exercise of his genius and skill. His

name was, like his father's, a familiar one among all classes of his countrymen.

Throughout the greater portion of his career the younger Stephenson had to combat an inherent diffidence regarding his own abilities. This was doubtless to be attributed to the delicacy of his nervous organisation and the modesty of his disposition. He never searched after fame. On the contrary, fame waited upon his genius and heralded his achievements. He never sought to appropriate to himself the honour due unto another. A pleasing feature in his character was found in his ardent attachment to all his pupils who evinced an aptitude for following their profession with success. There were no members of the body politic for whom he entertained a higher respect than for industrious and intelligent workmen. While he always endeavoured to be present at the carnivals of Epsom and Ascot, he never wagered a shilling on the chance of a horse-race. Fond of a rubber at whist, he was never known to play for high stakes. To speculations in general he entertained an unconquerable aversion. Instead of taking, as he did, a conspicuous position in London society, he would have preferred to have lived within the sound of his workmen's hammers, and near the Northumbrian village where he had spent his youth. The mortal part of Robert Stephenson rests within Westminster Abbey.

CHAPTER I.

RICHARD TREVITHICK THE INVENTOR.

IN giving prominence herein to the lives and labours of George and Robert Stephenson, a desire has been felt to do simple justice to the memory of the distinguished father and son who together occupied a foremost place during the early struggles for the establishment of the railway system. Their meritorious work and pronounced success entitle their biographies to more than ordinary attention and regard. To a large extent, however, the two great engineers reaped advantages from the efforts of others in the same direction. Neither could be said to be a great inventor, although both possessed the constructive faculty in a remarkable degree, and were able to turn, in a conspicuous manner, the partial successes or comparative failures of some of their contemporaries to profitable, personal, and public account. Their powers of observation and application were acute and untiring; therein lay the secret of their marked influence and fame. But they reaped rewards for which others had also toiled amidst difficulties, discouragements, heart-burnings, and neglect. We have now to notice the checkered career of the first inventor of a railway travelling-engine: a child of Genius who died penniless.

The locomotive of to-day is the grand result of a continuous series of improvements upon a model which came from the hand of its inventor and constructor in a somewhat crude and incipient form. These improvements have been effected, from time to time, through the research or ingenuity of various mechanical engineers, professional and amateur. The original form was conceived by one of those restless sons of Invention who have neither the patience nor the energy necessary to carry on successfully a warfare against popular apathy, prejudice, or ingratitude.

Richard Trevithick was born in the parish of Illogan, Cornwall, on the 13th of April 1771. His birthplace formed a centre around which clustered, within the radius of a mile, the famous mines of Dolcoath, Cook's Kitchen, Pool, Tin Croft, and Roskear. Richard was named after his father, who was manager of some of the principal Cornish mines, that of Dolcoath being the headquarters of the elder Trevithick at the date of his son's birth. The cottage where the inventor of the earliest railway locomotive first saw the light is situated between the old Dolcoath Mine and Carn Brea Hill; but shortly after that event the family removed to a more eligible residence at Penponds, near Camborne, in which town young Trevithick received the barest rudiments of education, but that more on account of his own repugnance to the discipline of school than from any wish on the part of his parents to withhold from the boy means of advancement which their position in life might have enabled them to bestow. An only son, young Richard was indulged by his mother to an extent that rendered him, during his schooldays, impatient of the slightest restraint on the part of the master under whom he was placed at the unpretentious seminary of an unimportant town. It is said that the boy was fond of solitude, and preferred the drawing of lines and figures to the preparation of his legitimate lessons. A report from his teacher characterised him as

a disobedient, slow, obstinate boy, frequently absent from his place in the class, and when present, very inattentive to instruction. His precocity, however, may be inferred, for upon his master expostulating with him one day, on account of the total want of method which his sums exhibited upon the slate, Richard without hesitation said, in reply, "I'll do six sums to your one." The same spirit of obstinate independence clung to him through life.

When Richard's schooldays had ended, his father experienced much difficulty in his endeavours to train him into settled habits of industry and application. The lad chafed under control, and instead of sitting at a desk in the manager's office, chose rather to wander by himself through one or other of the mines then under his father's charge. His natural genius was soon made apparent to his seniors, however, for a difficulty having arisen among the mine agents as to the correctness of certain underground levels, Richard boldly offered to solve the problem which had puzzled older heads than his own. His extreme youth and wild disposition were not calculated to inspire the agents with confidence in his ability, and they at first disapproved of his interference; but being at length hard pressed for the solution of a question which had given them much trouble, they allowed the stripling to try his hand with the rude surveying instruments of the period. The course which Richard laid down was followed successfully, and the matured experience of manhood had for the occasion to acknowledge its inferiority to the precocious ingenuity of a boy.

As a young man Trevithick delighted in athletic exercises, and several stories illustrative of his great muscular strength have been told by the son of the engineer in a most interesting biography. He was noted as the only athlete able to throw a ball over the tower of Camborne Church while standing sufficiently near to touch the base with one foot. In a trial of strength between him and his companions upon

one occasion, several fruitless attempts had been made to lift from the ground a 9-inch cast-iron pump, weighing nearly a ton. But "Captain Dick," when his turn came to make the effort, raised the ponderous weight on to his shoulder and bore it triumphantly away. As a wrestler he had no equal. Going along a London street, in company with his friend Andrew Vivian, a party of pickpockets had marked the two simple-looking Cornishmen as suitable subjects for a predatory assault; but as soon as the light-fingered gentlemen began to hustle their intended victims, Trevithick seized two of them in a vice-like grip, and, knocking their heads together, he swung them about in a manner that caused the rest of the gang to fly from his presence in astonishment and fear. With ease he could write his name upon a beam about six feet above the floor, with his arm extended, and a 56-lb. weight suspended from his thumb. Had his will-power been at all proportionate to his muscular development, history might have been compelled to do homage to his memory as that of the greatest engineer of modern times.

The elder Trevithick was a mechanical genius of no mean ability. Before the advent of James Watt upon the scene, and before the first improved steam-engine by that celebrated inventor appeared in Cornwall, a friendly combination of local engineers and mine managers had existed for the purpose of mutual counsel and assistance in questions pertaining to the repair or improvement of the Newcomen engines then in use, and the efficient working of the mines. In that amicable clique Richard Trevithick, senior, was a ruling spirit, whose opinions and advice commanded the respect of his fellows. The old Cornish pumping-engines were necessarily of the most primitive description. The boilers were simply enlarged copies of those in domestic use, their flat tops or lids being weighted so as to cause the steam to be retained at a pressure of from one to two pounds

on the square inch. Trevithick was the first engineer, it is believed, who effected alterations in the construction of the Cornish engine and boiler of sufficient importance to call for special notice in the history of mechanical engineering in the great mining county of the South, previous to the introduction of Watt's improvements. The alterations in question were made by the manager of Dolcoath Mine while refitting an engine which had been discarded on account of its age and general debility. Upwards of forty years had passed since its first erection by Newcomen, and Trevithick determined to give a renewed existence to the worn-out machine. In its renovated condition it was considered to be the most perfect engine of the period in Cornwall. Some idea may be formed of the importance of the work from the cost of the whole, according to the present scales of wages, as such alterations could not now be made for a less charge than six thousand pounds. Not only was the machinery so reconstructed as to merit the title of the "Dolcoath New Engine," but the boiler, which was built under the manager's direction and from his plans, was the first erected in that district with the semi-circular top; the objectionable lid, weighted by slabs of granite, being discarded, with the result that the increased pressure in the stronger boiler materially augmented the power of the engine, and pointed out, in the most practical manner, the true source from which to derive further force and usefulness in the application of steam.

When the erection of the Dolcoath New Engine was completed under his father's direction, young Richard Trevithick was only four years of age, and consequently could take no interest for a time in the stirring warfare which began a year afterwards between the Cornish boiler-builders and the great inventor whose improved motive power for machinery was destined not only to revolutionise the mining world, but to give to manufactures and commerce

in general an unprecedentedly forceful impetus. But the war of extermination waged by James Watt against the Newcomen engine and its adherents was a prolonged one, and the younger Trevithick entered manhood with a deeply-seated hatred against those who had unsettled confidence in native mechanical engineers, which had existed in Cornwall for some generations. When Watt, in the year 1776, endeavoured to introduce his improved steam-engine to the Cornishmen, he found that his purpose could only be accomplished by leasing it at a rental payable according to the saving effected thereby in the consumption of fuel, when compared with the cost of firing for the old engines which the famous Scotchman was endeavouring to supplant. Under an arrangement of that character, Boulton and Watt erected, in 1777, their first engine in Cornwall, at the Wheal Busy Mine. The saving accomplished led to the placing of others at several workings, and upon similar terms, and the Cornish engineers, finding their reputation, if not their livelihood, at stake, endeavoured by all the means at their command to arrest the progress of the invaders upon their territory.

During an active life of fifty years the elder Trevithick was connected with the rise and prosperity of Cornish mechanical engineering, and he witnessed the decline thereof that followed, slowly but surely, the introduction of Watt's improvements. Having himself been the keenest opponent of Watt in Cornwall, he lived to find his son an engineer of considerable natural genius, and engaged also in contesting the claims of the great Scotch engineer and inventor to pre-eminence among the constructors of motive machinery in the district famed for Druidical tradition and metalliferous mines. Richard Trevithick, senior, died at Penponds on the 1st of August 1797, and was interred in the neighbouring churchyard of Camborne.

At the time of his father's decease, Richard Trevithick

was the engineer at the Ding Dong Mine, near Penzance, where an injunction was laid upon an engine which he had erected, on account of an infringement of Boulton and Watt's patent rights. Fruitful in resources, Trevithick avoided payment to the patentees by converting the engine into an open-top cylinder atmospheric, without beam or parallel motion. But that was but an instance of many encounters which the young and daring Cornishman successfully sustained when in arms against Watt and his demands as a patentee. So far from feeling the slightest compunction in regard to the injustice suffered by his rival, Trevithick considered that everything was fair in war, and he exulted in the fact that the power of the law had been evoked against himself, but only to be baffled by the exercise of his own ingenuity. In justice, it may be remarked that neither the spirit nor the action of the Ding Dong engineer were at all singular among his class in Cornwall, for all Trevithick's mechanical brethren in the South then regarded a clever infringement of a patented improvement as a just retaliation for losses sustained by themselves through the competition of powerful professional opponents. To the position vacated by his father Richard succeeded, as much by his personal fitness as on account of the name which he bore; accordingly we find him supplying machinery simultaneously to at least nineteen mines, several of which were, at the period, among the most important in that county.

Boulton and Watt erected many engines in various parts of the country, on the agreement, in each case, that a rental equivalent to one-third of the fuel saved by the engine would be paid to the patentees. All the Watt engines built by the firm for Cornish mining purposes were leased under that condition, but considerable difficulty was frequently experienced in the settlement of accounts by the lessees. To obviate contentions in regard to the saving actually effected in particular cases, Watt invented a

mechanical contrivance, called *the counter*, by means of which every stroke made by an engine was duly recorded. That registering clock, no doubt, prevented many disputes from arising between the engineers and their clients; but another fruitful source of contention and annoyance to the inventor and his partner could not be dealt with so easily—namely, the frequent infringement of their patent rights. For a long time litigation even seemed unable fully to counteract the latter evil, for a powerful section of the Cornish engineers and mining adventurers opposed such a bold front to the onslaught of the lawyers as threatened at one time to involve poor Watt and his friends in ruin irretrievable. As early as 1796, Richard Trevithick was known in certain legal circles as "the tall and strong young man who cared not for James Watt." In that year he gave evidence against the claims of his famous rival. But the title to distinction earned by Trevithick does not rest upon the circumstance of his unyielding opposition to an inventor more illustrious than himself. By his discovery of the great power which is concentrated in the direct pressure of steam, above that produced by the vacuum of the low-pressure engine of Watt, he paved the way for the railway locomotive of to-day, and made himself worthy of the gratitude of his countrymen.

In all probability the success which followed the introduction of Watt's low-pressure engine impelled Trevithick to endeavour, in self-defence, to produce a motive machine of as great efficiency as his rival's, while non-liable to charges occasioned by the use of any part of Watt's patented improvements. That Trevithick succeeded to some extent in this is evidenced by the fact that many of the ingenious Cornishman's original high-pressure engines have been at work in his native county until a comparatively recent period, and the important principle upon which these improved machines were constructed—namely, a total reliance

on the direct pressure of the steam on the piston for their power, enabled the inventor to arrive at conclusions which conduced to the turning of his attention to the practicability of steam locomotion on common roads.

It is believed that the first model of a locomotive steam-engine, before the period of the tramroad, was constructed by Cugnot, a French engineer, about the year 1763. The idea had previously been propounded by Savery, the inventor of the working steam-engine, and also by Dr. Robison, the friend and counsellor of James Watt; but no attempt had hitherto been made to give practical effect to the notion of applying steam-power in the traction of carriages. Cugnot's locomotive is said to have been devised for the purpose of hauling cannon into action without the aid of horses, and a full-sized engine was built on Cugnot's plan at the cost of the French Government; which machine was tried in the year 1769, in the presence of the Minister of War and a distinguished party of military engineers. During one of the experiments the engine knocked down a wall that stood in its way; but its speed, when under a load of four persons, did not exceed two-and-a-half miles per hour, while that slow rate of progression could only be sustained for fifteen minutes at a time, owing to the smallness of the boiler. In 1770 the inventor constructed an improved engine, which was tried in the streets of Paris; but it was considered as too dangerous an innovation upon the thoroughfares of the French capital; for, being overturned in its passage round a corner, it was locked up in the arsenal, in order that the citizens might not suffer harm during any further peregrinations of the unsightly traveller. Cugnot's locomotive may be seen at the Conservatoire des Arts et Métiers, where it is preserved as an interesting relic of the mechanical ingenuity of the last century.

Cugnot's invention paved the way for the researches of other mechanical engineers into the region of unexplored

experiment, and the great problem of steam locomotion engaged the attention of Oliver Evans, an American, who invented a locomotive for ordinary roads in 1772, and obtained sanction from the authorities of the State of Maryland to make and use steam carriages in his own exclusive right. That concession was granted to the inventor in the year 1787; but it would appear to have been of little value to him, for the American locomotive, like its French forerunner, never came into general employment.

About the year 1784, William Symington, whose name is associated with the early projection of steamboats, also endeavoured to utilise steam-power in the traction of carriages; and a working model of a steam coach was exhibited by the inventor before the professors of learning in the College of the Modern Athens. The bad state of the roads that then prevailed in Scotland prevented Symington from prosecuting his scheme of steam-transit on land, and he turned his attention to water-conveyance as offering better facilities for bringing his ideas into practical and profitable shape. While this Scotch inventor was engaged in constructing the model of his steam carriage in the North, William Murdock was similarly employed in the South, at Redruth, Cornwall. Murdock's model was of Liliputian proportions, and the idea had been suggested to Watt's friend and confidential assistant by the distinguished inventor whose interests he resided at Redruth to protect. The little engine resembled Cugnot's in being placed upon three wheels. It was constructed on the high-pressure principle, the steam being generated by the heat from a spirit-lamp. Fearful that one or another of the Cornish Ishmaelites might appropriate the idea, and embody the same in an altered form, Murdock resolved to conduct his trials under the shelter of night, and within the precincts of a narrow footpath leading to the parish church, and about a mile from the town. Having lit the lamp-fire of his

model, Murdock soon had the satisfaction of seeing the tiny locomotive in motion, and it fairly outran the speed of its constructor, who followed it, in its hissing and zigzag career, at a pace comparatively slow by reason of the darkness of the night. Either from the unsatisfactory results of his experiments, or, which is more likely, from the discouragements he received from his patron Watt, Murdock abandoned his purpose of effecting road locomotion by steam-power, upon which he had employed a considerable amount of time and labour, and left the question, as he had found it, practically unsolved.

When William Murdock was experimenting in order to produce, if possible, an effective steam locomotive for the highways of the country, Richard Trevithick was a boy of thirteen; and it is at least questionable whether the latter ever heard of the midnight trial which had been conducted by the clever assistant to his father's opponent, previous to attempts made by himself, with a similar view, some years afterwards.

By numerous experiments, conducted under the most harassing circumstances, Richard Trevithick had arrived at the conclusion that a steam-engine would work satisfactorily without an air-pump or condensing water; that foundations of masonry were not necessary; that neither the beam nor parallel motion was essential to the efficiency of the machine; and that the boiler for supplying steam at a high-pressure need not weigh one-quarter of the weight of those then used for generating steam at a low-pressure, while producing an equal amount of power. He found, therefore, that a considerable saving would result from the use of his high-pressure engine, and he had one conveyed from mine to mine in a cart, so that he might be able readily to give practical demonstrations of the great value of his discoveries. While thus engaged in a crusade against Watt's low-pressure engine, Trevithick resolved to utilise the power of his own

in conveying it from place to place, so as to save the cost of cartage, and the experiments that he made to this end led him to take up the problem of steam locomotion in a more comprehensive form. Having successfully applied high-pressure steam to the working of the portable whim, the application thereof to carriage traction followed almost as a natural consequence under the circumstances named. Although unable to discover the date of Trevithick's earliest experiments in locomotive construction, there is good evidence of the fact that his first steam-carriage was built in 1800, the parts having been put together at a smith's shop in Camborne in that year. On Christmas-eve 1801, the first load of passengers ever moved by the force of steam, in a carriage specially designed for such a purpose, was driven through the street of a small town in Cornwall by the inventor of the machine. The following account of the preliminary trial of Trevithick's road locomotive appeared in the *Mining Journal* of the 2nd of October 1858 :—

"With regard to the Cornwall engine, Mr. John Petherick, writing to his nephew, Mr. Edward Williams, says :—'Cardiff, September 11th, 1858. I perfectly remember, when a boy, about the year 1800, seeing Trevithick's first locomotive engine, worked by himself, come through the principal street of Camborne, in Cornwall. This experiment was satisfactory only as long as the steam pressure could be kept up ; and during that continuance Trevithick called upon the people to "jump up," so as to create a load on the engine, and it soon became covered with men, who did not seem to make any difference to the power of speed, as long as the steam was kept up. This was sought to be done by the application of a cylindrical horizontal bellows worked by the engine itself, instead of a stack ; but the attempt to keep up the power of the steam for any considerable time proved a failure. There were other experiments made which I heard of, but did not witness ; but the same objection prevailing, caused the attempt to be laid aside for that time. This was the first public exhibition of the invention.'"

Although Trevithick was not the earliest inventor of a steam locomotive for common roads, sufficient was accomplished by him to stamp his production as the result of great

mechanical genius and ability, for it ought to be borne in mind that he carried on, unassisted by the capital of others, and for some years, researches and experiments with a view to solving the question of steam locomotion in a manner best calculated to render it acceptable to the scientific thought and commercial enterprise of the country. His efforts in that direction, however, met the fate usually awarded to those of inventors who are far in advance of their time; and the road locomotive, which had been made under his eye and after his plans, was regarded more as a huge scientific toy, which had been designed especially for public exhibition, than as the possible precursor of a race of mechanical leviathans that might eventually overrun the habitable portions of the globe.

CHAPTER II.

TREVITHICK'S RAILWAY LOCOMOTIVES.

TOWARDS the close of the year 1801 Trevithick went into partnership with his cousin, Andrew Vivian, who was also a Cornish mining engineer, and shortly thereafter the two friends proceeded to London for the purpose of securing patent protection for the invention of a locomotive. On the 24th of March 1802, a patent was granted to Trevithick and Vivian for "steam-engines for propelling carriages, etc.," and the patentees were encouraged to build a locomotive, specially for exhibition in the Metropolis, from the favourable opinions respecting the specification of the invention which had been expressed by eminent scientific authorities, such as Sir Humphrey Davy, Mr. Davies Gilbert, and Count Rumford. Trevithick's first locomotive had in the meantime come to an inglorious end; and the circumstances that conduced to its destruction have been detailed by Mr. Davies Gilbert, from a personal recollection of the event. Writing on the 29th of April 1839, Mr. Gilbert describes the final trial of the "Camborne Road Locomotive" as follows:—"The travelling-engine took its departure from Camborne Church Town for Tehidy, on the 28th of December 1801, where I was waiting to receive it.

The carriage, however, broke down, after travelling very well, and up an ascent, in all about three or four hundred yards. The carriage was forced under some shelter, and the parties adjourned to the hotel, and comforted their hearts with a roast goose and proper drinks, when, forgetful of the engine, its water boiled away, the iron became red-hot, and nothing that was combustible remained either of the engine or the house." It is rather a sad reflection that the first passenger coach propelled by steam-power should thus have fallen an early victim to the punch-drinking propensities of the period. Better had it existed until, in hoary age, it found an asylum among the interesting mechanical relics at South Kensington!

Trevithick's second road locomotive was tried at Camborne about the end of 1802, or the beginning of 1803, and it was forwarded to London in January of the latter year. It was a great improvement upon any which had preceded it, being lighter in construction and steadier when in motion, by the substitution of a horizontal cylinder for the vertical one which had formed part of the first Camborne locomotive. The boiler was wholly made of wrought-iron, and was put together, with the engine attached, at or near Felton's Carriage Shop, in Leather Lane, Holborn. Vivian, Trevithick's partner, drove it one day from Leather Lane to Paddington and back; not a bad performance when we consider that Andrew Vivian was not a mechanical engineer, and that the journey was made, for a distance of ten miles, through some of the thoroughfares of the Metropolis. On the occasion of a subsequent trial under Trevithick's own auspices, and with his cousin John Vivian as steersman, the engine was started about four o'clock in the morning, and went along Tottenham Court Road and the New Road, sometimes at the rate of eight or nine miles an hour. The trip was suddenly brought to a conclusion, however, by the locomotive swerving to the side of the road, and tearing

down six or seven yards of railing from a garden wall, when the owner of the despoiled fencing put his head out of the window of his bed-room and remonstrated with the luckless invaders of his quietude, in tones more stentorian than polite. Briefly, Trevithick's "London Locomotive" commenced a series of trials in the Metropolis shortly after its arrival in January 1803, and these were continued for seven or eight months, until the capital of the enterprising Cornishmen became thoroughly exhausted, and that without single order having been received for the steam-carriag which had been brought so many miles with the hope of supplanting, to some extent, the use of horses in the traffic of modern Babylon.

In spite of the disheartening circumstances which had followed Trevithick's locomotive experiments in the Metropolis, the inventor determined to put to a speedy and practical test a theory that had been brought forcibly to his mind during his stay—namely, that a smooth road of iron would be the best antidote to the jolting which he had experienced while travelling in his steam-carriage upon the uneven pavements of London's streets. That theory had already been presented to him during his experiments upon the Cornish roads, but it received considerable confirmation during the Metropolitan trials, and he lost no time in endeavouring to solve the great problem of railway locomotion by steam-power that now lay before him. That he failed to do so conclusively may be attributed to the want of encouragement from an apathetic public, or from his own deficiency in the qualities of perseverance and energy so necessary to an inventor, rather than from any personal lack of mechanical skill and ingenuity. His contemporaries never doubted Richard Trevithick's ability as an engineer, and professional rivals had frequent and abundant opportunities for considering the first inventor of a railway locomotive as one who was far too skilful and ingenious to be pleasant.

While carrying on his experiments in road locomotion, Trevithick's restless genius had busied itself also in the endeavour to enlist the co-operation of capitalists on behalf of a locomotive for traction on tramroads. In this he so far succeeded as to get the Coalbrookdale Company, of Shropshire, to construct from his plans an engine capable of ocular demonstration of the power concentrated in steam at high pressure. Dubious regarding the efficiency of a steam engine which discarded Watt's air-pump and condenser, but impressed in all probability by the confident tone of the inventor, an engine was built by the company, under Trevithick's supervision, which contained some of the essential features of the modern locomotive, while it was adapted to force water a certain height, so that its power might be accurately measured by those who doubted the statements of the perhaps too sanguine designer as to its capabilities. As the machine in question was the immediate precursor of Trevithick's tramroad locomotive, the following extracts from a letter, written by the inventor to his friend Davies Gilbert, are historically interesting, as showing the difficulties that beset the first introduction of the iron-horse by its unfortunate contriver. The letter was dated, "Coalbrookdale, Shropshire, August 22nd, 1802," and it describes the proportions and qualities of the machine as follows:—

"The boiler is 4 feet diameter; the cylinder 7 inches diameter, 3 feet stroke. The water-piston is 10 inches in diameter, drawing and forcing 35 feet perpendicular, equal beam. I first set it off with about 50 lbs. on the inch pressure against the steam-valve, without its load, before the pumps were ready, and have since worked it several times with the pumps, for the inspection of the engineers about this neighbourhood.

"The steam will get up to 80 or 90 lbs. to the inch in about one hour after the fire is lighted. The engine will set off when the steam is about 60 lbs to the inch, about 30 strokes per minute, with its load. There being a great deal of friction on such small engines, the steam continued to rise the whole time it worked; it went from 50 to 145 lbs. to the inch, in fair working, 40 strokes per minute. It became so unmanageable as

the steam increased, that I was obliged to stop and put a cock in the mouth of the discharging pipe, and leave only a small hole of $\frac{1}{4}$ by $\frac{3}{8}$ of an inch for the steam to make its escape into the water. The engine will work 40 strokes per minute with a pressure of 145 lbs. to the inch against the steam-valve, and keep it constantly swimming, when burning 3 cwt. of coal every four hours. I have now a valve making to put on the top of the pumps, to load with a steelyard, to try how many pounds to the inch it will do of real duty, when the steam on the valve is 145 lbs. to the inch.

"I cannot put many more pumps, as they are very lofty already. The packing stands the heat and pressure without the least injury whatever. . . . As there is a cock in the discharging pipe which stops the steam after it has done its office on the piston, I judge that it is almost as fair a trial as if the pump-load was equal to the power of the engine. Had the steam been wire-drawn between the boiler and the cylinder it would not have been a fair trial, but being stopped after it has passed the engine, it tells much in its favour for bearing a greater load than it has now on.

"The boiler will hold its steam a considerable time after the fire is taken out. We worked the engine three-quarters of an hour after all the fire was taken out from under the boiler. It is also slow in getting up, for after the steam is atmosphere strong, it will take half-an-hour to get it to 80 lbs. or 90 lbs. to the inch. It is very accommodating to the fireman, for, fire or not, it is not soon felt.

"The engineers at this place all said it was impossible for so small a cylinder to lift water to the top of the pumps, and degraded the principle, though at the same time they spoke highly in favour of the simple and well-contrived engine. They say it is a supernatural engine, for it will work without either fire or water, and swore that all the engineers hitherto are the biggest fools in creation. They are constantly calling on me, for they all say they would never believe it unless they saw it, and no person here will take his neighbour's word, even if he swears to it. They all say it is an impossibility, and they will never believe it unless they see it. After they had seen the water at the pump-head, they said that it was possible, but that the boiler would not maintain its steam at that pressure for five minutes; but after a short time they went off, with a solid countenance and a silent tongue.

"The boiler is $1\frac{1}{2}$ inch thick, and I think there will be no danger in putting it still higher. I shall not stop loading the engine until the packing burns or blows out under its pressure."

The experiments thus carried on at Coalbrookdale appear

to have been in some measure satisfactory, for in the face of professional unbelief in Trevithick's high-pressure principle, the company commenced the building of "a carriage for the railroads;" but whether the construction was ever carried out to completion remains, unfortunately, a mystery, as do also the contemplated "railroads" of the year 1802. As we have already noticed, the inventor was now busy with his Camborne locomotive for common roads, and he went to London, about four months after the Coalbrookdale trials, where he was not only busy for some eight months in prosecuting his locomotive schemes, but in constructing stationary engines upon the high-pressure principle, under the patronage and approval of the Admiralty; which engines, in the words of Trevithick's son, "burnt less coal than the Boulton and Watt low-pressure steam vacuum engines, that had before driven the same machinery." It is quite possible that in following other projects in the earlier part of 1803, the Coalbrookdale steam-carriage was neglected by its impulsive and headstrong designer. Be that as it may, however, we find him, in October 1803, or shortly after his Metropolitan experiences, busily employed in constructing a tramway travelling-engine at Penydarran, in South Wales. Trevithick's "Welsh Locomotive" has been designated "the pioneer of railway engines." Mr. Thomas Ellis, senior, of the Tredegar Works and Tymaur, Pontypridd, has described it as follows:—"The engine had one cylinder eight inches in diameter and two-feet stroke; a wrought-iron boiler, with a tube thus, U; the side rods connected to the wheels; and as side coupling rods were not thought of then, it had cog-wheels connecting front and hind axles. To pass the centres it had a fly-wheel. Weight of engine about seven tons, on four wheels." Mr. Ellis published a drawing of the locomotive, about a quarter of a century ago, along with some interesting particulars, as annexed:—

"Trevithick's high-pressure tram-engine, so designated in the original plan, dated 1803, was constructed partly in Cornwall and partly at Penydarran Works, by Richard Trevithick, Esq., engineer, for Samuel Homfray, Esq., proprietor of the Penydarran Iron Works, Merthyr Tydfil, who, while discussing the principles and feasibility of locomotive steam-engine power with Richard Crawshay, Esq., of the Cyfarthta Iron Works, made a bet of 1000 guineas that he would convey by steam-power a load of iron from his works to the Navigation House—nine miles distant—along the Basin tramroad, which he effected by means of this engine, and won his wager, although the heavy gradients, sharp curves, and frangible nature of the cast-iron trackway operated against the return of this ingenious, though rudely constructed, machine with the empty trains; hence its discontinuance. As may be perceived, the exhausted steam discharged into the stack, and the wheels combined; thus to Trevithick is the credit due for the application of those two principles to locomotive engines.

"Rees Jones, who aided in the fitting, and William Richards, its driver, are still alive; the former, when shown the plan, instantly identified it; and the latter, now in his eighty-fifth year, has worked no other than Trevithick's high-pressure engine. To this day portions of the old engine exist in the one he now works at Penydarran, and during a period extending far beyond half a century never having had an accident with his boiler."

The accuracy of the description given by Mr. Ellis, of the first tramroad locomotive, is confirmed by the following carefully-attested evidence on the subject that appeared in the *Mining Journal* of the 2nd of October 1858:—

"Rees Jones, engine-fitter, Penydarran, says:—'Dowlais, September 9th, 1858.—I am now eighty-two years old. I came to Penydarran on April 1st, 1794. I was then eighteen years of age. I have been in the employ of the Penydarran Iron Company ever since. I am still able to do a little. I am in the works every day. About the year 1800 Mr. Trevithick came to Penydarran to erect a forge-engine for the company. I was at this time overlooking the engines at Penydarran. I assisted Mr. Trevithick in the erection of the forge-engine. When this engine was finished Mr. Trevithick commenced the construction of a locomotive. Most, if not all, the work of this locomotive was made at Penydarran. Richard Brown made the boiler and the smith-work. I did the most of the fitting, and put the engine together. When the engine was finished she was used for bringing down metal

from the furnaces to the old forge. She worked very well; but frequently, from her weight, broke the tram-plates, and also the hooks between the trams. After working for some time in this way, she took a journey of iron from Penydarran down the Basin Road, upon which road she was intended to work. On the journey she broke a great many of the tram-plates; and before reaching the Basin she ran off the road, and was brought back to Penydarran by horses. The engine was never used as a locomotive after this; she was used as a stationary engine, and worked in this way several years.

"'I understood the reason for discontinuing using her as a locomotive was the weakness of the road. The boiler was made of wrought-iron, having a breeches tube also of wrought-iron, in which was the fire. The pressure of steam used was about 40 lbs. to the inch. The cylinder was horizontal; it was fixed in the end of the boiler. The diameter of the cylinder was about $4\frac{3}{4}$ inches. The three-way cock was used as a valve. The engine had four wheels. These wheels were smooth; they were coupled by cog-wheels. There was no rack-work on the road; the engine progressed simply by the adhesion of the wheels. The steam from the cylinder was discharged into the stack.' —This statement was made in the presence of the undersigned, W. MENELAUS, G. MARTIN, W. JENKINS."

Mr. Menelaus, one of the signatories to the report received from the old engine-fitter of Penydarran, says:—"I would call particular attention to the fact that Trevithick, in 1803, had satisfied himself that smooth wheels would have sufficient adhesion to propel a load; that he had hit upon the plan of coupling the wheels; and that he discharged the waste steam into the stack. Boilers of the same type as that used by Trevithick in this engine were used successfully for locomotives twenty years after his invention."

It has been doubted whether the ingenious Cornishman was ever fully alive to the great accession of force which the Steam Blast was fitted to confer when rightly applied to the Locomotive. Be that as it may one thing is certain, that Trevithick's first plate-way engine contained the germ of that important principle, for the primary application of which, in a thoroughly effective manner, more than one of his successors in mechanical engineering have endeavoured to substantiate

their claims as the original inventors. The foregoing testimony confirms the opinion expressed regarding the powers of the Welsh Tramway Locomotive in a letter written by Trevithick to his friend Mr. Gilbert, on the 20th of February 1804, immediately after a succession of trials had satisfied the engineer that the new machine could run with facility up and down inclines of one in fifty, and with a plentiful supply of steam. He writes from Penydarran:—"The tram-waggon has been at work several times. It works exceedingly well, and is much more manageable than horses. We have not tried to draw more than ten tons at a time, but I doubt not we could draw forty tons at a time very well; ten tons stand no chance at all with it. . . . The engine, with water included, is about five tons. It runs up the tramroad of two inches in a yard forty strokes per minute with the empty waggons. The engine moves forward nine feet at every stroke. . . . The steam that is discharged from the engine is turned up the chimney about three feet above the fire, and when the engine works forty strokes per minute, 4½ feet stroke, 8¼ inches diameter of cylinder, not the smallest particle of steam appears out of the top of the chimney, though it is but eight feet above where the steam is delivered into it, neither at a distance from it is steam or water found. . . . The fire burns much better when the steam goes up the chimney than when the engine is idle. I intend to make a smaller engine for the road, as this has much more power than is wanted here."

A considerable amount of acrimony has from time to time been imparted into discussions regarding the invention and improvement of the Locomotive. The reason of this in all probability lies in the fact that mechanical engineers, without the slightest intention to act unjustly towards their professional brethren, have been betrayed into considering their own discoveries as original, when in reality these were but the resuscitated ideas or inventions of others. The

history of the steam-engine affords several instances of the application of improvements which had been independently devised by different heads, at different times, to the mysti fying of the modern student of mechanical invention. Our present purpose, however, is to establish Trevithick's claims to priority in the production of a railway locomotive of considerable efficiency, and to point out the services which were subsequently rendered by others, with a view to bring Trevithick's conception into general appreciation and use. If some of his contemporaries and followers desired to appropriate to themselves discoveries that independent testimony now shows to have been his by right of priority, it must be allowed that in those comparatively early days of English engineering there did not exist a society of Mechanical Engineers founded for purposes of mutual counsel and assistance. On the contrary, Trevithick's period was marked by professional rivalry and jealousies to which the present age is, happily in this particular, at least a stranger. It is not surprising, therefore, that engineers, in the beginning of the century, rather courted secrecy for their inventions than published these to the world, only to be adopted by rivals who were sometimes not very scrupulous in their dealings with business opponents. Hence the uncertainty which has surrounded to some extent the Locomotive's infancy, and hence the source of much acrimonious contention and debate. Viewing the matter dispassionately, we think there is strong evidence in support of an assertion made in the columns of *Engineering*, of date the 27th of March, 1868. The writer says:—"Trevithick was the real inventor of the locomotive. He was the first to prove the sufficiency of the adhesion of the wheels to the rails for all purposes of traction on lines of ordinary gradient, the first to make the return flue boiler, the first to use the steam jet in the chimney, and the first to couple all the wheels of the engine."

Again, Luke Hebert, in his practical treatise on *Railroads and Locomotion*, published in 1837, says:—

"From all the information that we can glean in tracing out the early history of locomotion, this remarkable circumstance presents itself: that when Trevithick's carriages with smooth wheels were employed upon levels, or slightly inclined planes, invidious comparisons with others having cogs were made against the former, because, as was asserted, they slipped and could not ascend such acclivities as the latter; and this, notwithstanding Trevithick first suggested, by his 'cross-grooves and fittings to railroads,' the very principle of the cogs, in a less objectionable form, and 'all other appliances to boot' of the engine and boiler contained in the said locomotive! Thus Trevithick lost many orders, and they were given to those who adopted all the essentials of his plans, without acknowledgment, and employed them as the basis of their structures; and when, after the lapse of years, it was found out by these gentlemen that smooth wheels had sufficient 'bite' of the rail in most circumstances, they made that fact appear to be their own discovery, notwithstanding it is stated in Trevithick's specification of 1802, and was confirmed by his practice; which practice they at first condemned with one general voice; and when at last they were compelled to practice it also, they endeavoured to make it appear as vastly superior to Trevithick's mode of surrounding his wheels 'with heads of nails, bolts, and claws,' which he never used at all! These ungenerous proceedings against the most eminent mechanic of his time appear to have been going on uncheeked from 1802 up to the present time—1836."

Between the years 1804 and 1808 Trevithick was busily employed in superintending the erection of his high-pressure stationary engines in various parts of the country, including the Metropolis, and he occasionally gave attention during that period to the Locomotive, by endeavouring to excite an interest in its favour among ironmasters and the proprietors of collieries. In these latter efforts, however, the inventor met with but little encouragement from capitalists; and in the forlorn hope of forcing the general public to acknowledge the superiority of steam traction in passenger conveyance, he boldly challenged a popular verdict for his invention by constructing a temporary railway in London, and exhibiting

thereon the iron-horse which his busy brain had conjured into existence.

Under his direction had already been constructed three road locomotives, one of which, as we have seen, was tried in the Metropolis, and three tramroad engines; the parts of one of the latter being put together, if not wholly constructed from his plans, at Gateshead-upon-Tyne, to the order of Mr. Blackett, of the Wylam Colliery. But Trevithick's locomotive of the year 1808 exceeded in simplicity all his former ones, as he therein discarded the gear used in coupling the wheels of his previous locomotives, and relied upon one pair of driving wheels for the traction of the engine and its carriage-load of passengers. The engine was named "Catch-me-who-can," and the enclosure wherein it was exhibited was situated near to the site where now stands the station of the London and North Western Railway; a circular plateway being laid specially for the purpose of the exhibition. The following letter, written by an engineer well known in his time, appeared in the *Mechanics' Magazine* of the 27th of March 1847, and is interesting as furnishing reliable information regarding an event of some consequence in the early history of steam locomotion. Addressing the editor of that journal, the writer says:—

"SIR,—Observing that it is stated in your last number (No. 1232, dated the 20th instant, page 269), under the head of 'Twenty-one Years' Retrospect of the Railway System,' that the greatest speed of Trevithick's engine was five miles an hour, I think it due to the memory of that extraordinary man to declare that about the year 1808 he laid down a circular railway in a field adjoining the New Road, near or at the spot now forming the southern half of Euston Square; that he placed a locomotive engine, weighing about ten tons, on that railway, on which I rode, with my watch in hand, at the rate of twelve miles an hour; that Mr. Trevithick then gave his opinion that it would go twenty miles an hour, or more, on a straight railway; that the engine was exhibited at one shilling admittance, including a ride for the few who were not too timid; that it ran for some weeks, when

a rail broke and occasioned the engine to fly off in a tangent and overturn, the ground being very soft at the time. Mr. Trevithick having expended all his means in erecting the works and enclosure, and the shillings not having come in fast enough to pay current expenses, the engine was not again set on the rail. I am, sir, your obedient servant, JOHN ISAAC HAWKINS, Civil Engineer, London."

For some time before and during the exhibition of Trevithick's "Catch-me-who-can," the inventor had been engaged in superintending, as engineer of the undertaking, the construction of a Driftway under the Thames, but the failure of the latter scheme, added to the disappointment and chagrin occasioned by the heavy loss which had attended the exhibition of his locomotive, together with patent law proceedings and bankruptcy, drove him, broken in spirit and shattered in health, into retirement for a period, and caused him to form a resolution to leave the great question of steam locomotion to be dealt with by others according to the changes or chances of fate. That it was with some reluctance that resolution was formed was apparent throughout his after-career; and amidst all the various inventions and schemes that occupied his attention from time to time, the thought of his countrymen's apathy towards the greatest of all his purposes for the public benefit pressed heavily upon his mind. We make no apology for transcribing the annexed communication in its entirety, seeing that it illustrates, better than by the pen of a biographer, phases of the character and genius of the famous Cornish inventor. Writing from Camborne, on the 26th of April 1812, Trevithick says:—

"TO SIR JOHN SINCLAIR.—I have your favour of the 4th instant, informing me that you had sent my letter, respecting propelling ships by steam, to the Navy Board; and also requesting a drawing and statement of the thrashing-engine to be sent to the President of the Board of Agriculture, which shall be forwarded immediately. I beg to trouble you with a few wild ideas of mine, which perhaps may some future day benefit the public, but at this time remain buried for want of encourage-

ment to carry it into execution. The average consumption of coals in large steam-engines is about 84 lbs. to lift 10,000 tons of water or earth one foot high. The average cost of this coal in the kingdom is sixpence. The average of a horse's labour for one day is about 4000 tons lifted one foot high, costing about five shillings. A man's labour for one day is about 500 tons lifted one foot high, costing 3s. 6d. I have had repeated trials of the water lifted by coals, horses, and men, proving that where a bushel of coal can be purchased for sixpence that sixpence is equal to 20s. of horse labour, and to £3, 10s. of men's labour. If you calculate a man to lift 500 tons one foot high, it is equal to 100 tons lifted five feet high; a very hard task for a man to perform in a day's work. This calculation proves the great advantage of elemental power over animal power, which latter, I believe, can in a great part be dispensed with, if properly attended to, especially as we have an inexhaustible quantity of coals.

"To prove to you that my ideas are not *mere* ideas, in general my wild ideas lead to theory, and theory leads to practice, and then follows the result which sometimes proves of essential service to the public. About six years ago I turned my thoughts to this subject, and made a travelling steam-engine, at my own expense, to try the experiment. I chained four waggons to the engine, each loaded with 2½ tons of iron, besides seventy men riding on the waggons, making altogether about 25 tons, and drew it on the road from Merthyr to the Quaker's Yard, in South Wales, a distance of 9¾ miles, at the rate of four miles per hour, without the assistance of either man or beast, and then, without the load, drove the engine on the road sixteen miles per hour. I thought this experiment would show to the public quite enough to recommend its general use; but though promising to be of so much consequence, has so far remained buried, which discourages me from again trying, at my own expense for the public, especially when my family call for the whole of my receipts from my mining concerns for their maintenance.

"It is my opinion that every part of agriculture might be performed by steam; carrying manure for the land, ploughing, harrowing, sowing, reaping, thrashing, and grinding; and all by the same machine, however large the estate. Even extensive commons might be tilled and effectually managed by a very few labourers, without the use of cattle. Two men would be sufficient to manage an engine capable of performing the work of 100 horses every twenty-four hours; requiring no extensive buildings or preparations for labourers or cattle, and having such immense power in one machine as could perform every part in its proper season, without trusting to labourers. I think a machine that would be equal to the power of 100 horses would cost about £500.

"My labour in invention I would readily give to the public, if by a subscription such a machine could be accomplished, and be made useful. It would double the population of this kingdom, for a great part of man's food now goes to horses, which would then be dispensed with, and so prevent importation of corn, and at a trifling expense make our markets the cheapest in the world; because there are scarcely any coals to be found except in England, where the extreme price, duty included, does not exceed 2s. per bushel.

"I beg your pardon for having troubled you with such a wild idea, and so distant from being carried into execution; but having already made the experiment above stated, which was carried out in the presence of above 10,000 spectators, who will vouch for the facts, I venture to write to you on the subject, for the first and only self-moving machine that ever was made to travel on a road, with twenty-five tons, at four miles per hour, and completely manageable by only one man, I think ought not to be dropped without further experiments, as the main point is already obtained, which is the power and its management.—Your most obedient servant, Richard Trevithick."

When the writer was penning the foregoing appeal on behalf of his "buried" locomotive, it rather singularly happened that one of his high-pressure engines was on its way to the mines of Peru, and without the knowledge of the inventor. A Swiss gentleman of considerable ability, named Francisco Uville, having at an early age visited Lima and the rich Peruvian mines in that neighbourhood, and finding that the silver mines at Pasco, about 150 miles from Lima, were falling quickly into decay, he considered it possible that the introduction of steam pumping machinery into the workings would restore the mines to their former celebrity. Uville came to England in 1811, and after the stay of a few months he was about to return to South America, when at the shop of a Mr. Roland, in Fitzroy Square, London, he accidentally observed the model of a steam-engine which had been made by Trevithick. Liking the simplicity of its construction, and desirous of testing it in the high latitudes of Pasco, Uville purchased the engine for twenty guineas, and took it with him to Lima. After

a successful trial of the machine on the Pasco mountains, a company was formed for the purpose of draining the mines in question, under an arrangement with the proprietors, and Uville was sent by the company to England in order to procure suitable steam-engines for service in the mines.

During his passage to this country the traveller frequently spoke to his fellow-voyagers of the object of his journey, and of his anxiety to find the whereabouts of the engineer whose name was on the model purchased in London. Speaking one day to a Mr. Teague, who was on board, the latter informed Uville that he was first cousin to the person wanted, and that Trevithick resided within a few miles of the port to which the packet was bound. Early in the summer of 1813 the "Fox," Captain Tilly, arrived at Falmouth, and without delay Uville was introduced to Trevithick, who was soon informed as to the circumstances and purport of the foreigner's mission.

Taking up his residence in the home of the Camborne inventor, Uville was instructed by his host, during a sojourn of several months, in matters pertaining to mining operations and machinery. After inspecting most of the Cornish mines, other districts in England were visited by Trevithick and Uville, in order that the best opportunities might be afforded to the latter for becoming acquainted with mining engineering, by examining the various engines at work. They then went to London, where Uville was introduced to a Mr. Campbell, an official of the East India Company, who informed his transatlantic visitor that the best European engineers were Boulton and Watt, of Birmingham, and that they were unquestionably the parties most likely to carry out successfully the construction of engines capable of being transported over a mountainous country to the mines of Pasco. Accordingly application was made to Trevithick's eminent rivals, who were informed both as to the character of the engines required, and the nature of the roads over

which they must be conveyed ere their destination could be reached; when Boulton and Watt returned an answer expressive of their opinion that the making of such small engines would be an utter impossibility. Trevithick, however, was not startled by the difficulties which the Cordillera opposed to the scheme, and having applied himself to the improvement of his engines, he contracted to supply nine of these at a cost of about ten thousand pounds. On the completion of the contract the engines were shipped on board the "Wildman," a South Sea whaler, which sailed from Portsmouth for Lima on the 1st of September 1814. Uville was accompanied, on his return trip to South America, by the following Cornish engineers, who were taken out to superintend the transit and the erection of the machines, namely, Thomas Trevarthen, Henry Vivian, and William Bull. The arrival of Trevithick's engines at Lima was celebrated by popular acclamation and a salute from the Government batteries, and on the 27th of July 1816, the first steam-engine was set a-going at Santa Rosa, one of the Pasco mines, under the charge of one of the Cornish engineers.

By virtue of his invested powers, Uville admitted Trevithick into the partnership of his company with a one-fifth share in the concern, and a handsome percentage on the profits. As soon, therefore, as the machinery had been shipped, the engineer made preparations for a journey to Peru, in order that he might personally look after interests that promised to constitute a source of considerable wealth to all the partnership; and to fulfil that purpose he sailed from Penzance, on the 20th October 1816, two years after Uville had set out for Lima with the engines. The arrival of the Cornish inventor was duly chronicled in the *Government Gazette* of Lima, and the following extracts from that journal, which were republished in the Cornish newspapers, supply information as to the nature of Trevithick's position

and prospects when he took up a residence in the vice-royalty of Peru. The letter from which the extracts were taken was dated from Pasco, 6th February 1817, and after detailing some highly successful results which had followed the working of the engines imported to the mines, the writer says:—

"To this agreeable news we ought to add that of the arrival of the whaling-ship 'Asp,' bound from London, having on board a large quantity of machinery for the Royal Mint, and for the constructing of eight engines more, equal to those in Pasco, with the advantage that they are of the last patent, and more easy to be worked; but what is of greater importance is the arrival of Don Ricardo Trevithick, an eminent professor of mechanics, the same who directed in England the execution of the machinery now existing in Pasco. This professor can, with the assistance of the workmen who accompany him, construct as many engines as are necessary in Peru, without any need of sending to England for any part of these vast machines. The excellent character of Don R. Trevithick, and his ardent desire for promoting the interests of Peru, recommend him in the highest degree to public estimation, and make us hope that his arrival in this kingdom will form the epoch of its prosperity, with the enjoyment of the riches enclosed it it, which could not be enjoyed without this class of assistance, or if the British Government had not permitted the exportation from England, which appeared doubtful to all those who knew how jealous that nation is in the exclusive possession of all superior inventions in arts or industry."

Trevithick's star now appeared to be in the ascendant. He had been received with many marks of respect and confidence by the Government and people of the country. His engines were working well, and had established for their designer a high reputation. The Royal Mint had been placed in the hands of the engineer and his partners, who received an immense income from the coinage; but dissensions and death soon raised difficulties and altered the complexion of surrounding circumstances; for Uville grew jealous of the English engineer's influence and authority, while one of the latter's trusted countrymen died within four months after the arrival of his chief. Uville had

desired to impress the Peruvians with the idea that to himself solely belonged the merit of introducing steam machinery into the working of their silver mines, and notwithstanding his obligations to Trevithick, the subtle Swiss sought every opportunity to oppose the Englishman in the direction of the operations. In order to render his opposition to Trevithick more galling and effectual, Uville formed a clique animated by his own feelings and example, and the engineer, knowing but little of the country or its manners, and disgusted with treatment that he had not deserved, retired from the concern, and forthwith proceeded on his own account to prosecute other important discoveries and schemes.

This very unsatisfactory state of matters continued until August 1818, when the sudden death of Uville caused his partners to solicit the assistance of Trevithick in the emergency. In the meantime two of the Cornish engineers had quitted this life—Henry Vivian, whose decease occurred shortly after Trevithick's arrival, and more recently William Bull, who had hailed from Chacewater. One man, therefore, only remained out of the four persons who had left England with the first cargo of machinery, and the principal partners in the company were in a manner driven to request the inventor to take the sole management of the mines: a position which had previously been his by virtue of an express agreement, and which he held with credit and profit to himself for nearly two years, when the war of independence swept like a scourge through the country, and the infuriated patriots, in their unswerving repugnance to all existing institutions, seized the engines at the mines, and threw the greater portion of the valuable machinery down the shafts. Thus were falsified, as by a death-blow, Trevithick's sanguine expectations of rapidly realising a fortune among the silver mines of the New World. Only one source of income now remained to him, namely, the working

of a mine in the province of Caxatambo, which had been conceded to him by the Government during his separation from Uville and the original company, whose operations he had left England principally to control. The solitary hope that now buoyed Trevithick's spirit, however, was likewise turned to disappointment, and the story of the catastrophe was told in his own words after the return of the engineer to England.

On the arrival of the revolutionary army in Peru, all the mineworkers under Trevithick deserted, in order to avoid enforced military service, and for a considerable time the engineer's position and prospects were of the most uncertain character, but the retreat of the Spaniards into the interior at length enabled him to take steps for the purpose of securing his rights in the mine under the new Government. Accordingly, he prepared a memorial and petition to the authorities, setting forth his claims, which were endorsed by a plan and description of the workings. In answer to these representations a formal grant was made to Trevithick of the interests held by him under the old Government, but unfortunately the chances of the revolution prevented him from following a scheme that had promised at one time a certainty of the greatest success, for upon the return of the Spanish troops, shortly after a recommencement of operations at the mine, every one was obliged to fly from the neighbourhood. During the long-protracted struggle that ensued, the luckless adventurer held possession of his property as best he could, until at length he also was compelled to quit that part of Peru, robbed of his money, and leaving all his possessions behind, including his mining implements and a quantity of ores ready for conveyance to the shipping port, and worth about £5000. Numerous as had been his disappointments, none were so sensibly felt as this, for the enterprise had been entirely of his own creation, and a handsome independence had seemed as within his grasp.

But revolution had followed revolution until the fearful succession appeared interminable. Even the arrival of Bolivar at Lima rendered Trevithick's circumstances if possible more depressing, for the engineer was forced into the army, where his inventive genius was turned to account in the construction of a carbine of a somewhat unique description. The stock and barrel were cast of brass, and in one piece, with a recess for the lock. The bullet was flat and cut into quarters, which were held together in a cartridge until separated at the moment of explosion, when these spread from the muzzle of the weapon and inflicted jagged wounds. In the ranks the inventor was called upon to prove the efficiency of his own gun, and afterwards was allowed by Bolivar, the Republican Governor of Peru, to return to the prosecution of more peaceful projects.

About the year 1822 Trevithick left Lima for Bogota, on a special mission for the governor, but on his way thither, putting in at Guayaquil, he heard of the existence of some rich mines in Costa Rica, and, having but little faith in Bolivar or his promises, he threw up his engagement and proceeded to the new El-Dorado, where he was engaged in mining schemes until about the year 1826, when he determined to return to England for the purpose of forming a company to work a mine which had been leased to him by the Government. After an adventurous journey, foot-sore, jaded, and without means, he arrived at Carthagena, in the hope of getting thence a passage to his native country. As already noticed in a former chapter, Trevithick had the good fortune to meet Robert Stephenson at the inn of that port, and the young engineer assisted his countryman to make the desired voyage without an appeal to the generosity or confidence of any master of a ship. The meeting of the two engineers under the circumstances suggests a reflection regarding their relative positions in the history of the Locomotive. The younger engineer was returning to England to

enter upon a career of distinction, wealth, and honour, during which he was to reap many of the fruits of Trevithick's genius and labours, and to find at length a resting-place for his remains within the most sacred mausoleum of Britain's noble and great men; while the inventor of the railway locomotive, after the buffetings of a ruthless fate, was about to encounter the coldness and ingratitude of his countrymen, in the refusal to recompense his services to the State, and to die poor and neglected.

In 1827 Trevithick arrived in England, after an absence of eleven years, and possessing nothing but the clothes he wore, a gold watch, drawing and magnetic compasses, and a pair of silver spurs; the latter the only memento of his sojourn in Peru, where at one period it had been seriously proposed to erect his statue in silver. But the sanguine adventurer expected an early influx of riches as his share of £500,000 saved in the Cornish mines through his engineering improvements, and he forgot, in the demonstrations of popular estimation accorded him, his present extreme poverty and past vicissitudes. Besides, he confidently looked for a speedy realisation of his hopes in regard to the projection of an English company to carry out his mining schemes in Costa Rica. His expectations of immediate or future advantage from his mechanical improvements or mining designs were, however, not to be realised, for advantage was taken of technical points to put off his claims for remuneration for the services he had rendered to the ore-proprietors of his native county, while he could never come to what he considered fair terms with those who were inclined to further his desire in the formation of a company for his proposed operations in Costa Rica, and he broke off the negotiations in a fit of disappointment and anger. Briefly, Trevithick got nothing for the relinquishment of either of his properties beyond the Atlantic.

On behalf of the inventor a petition to the Commons,

dated the 27th of February 1828, was placed in the hands of his staunch friend Davies Gilbert, M.P. The document stated, "That this kingdom is indebted to the petitioner for some of the most important improvements that have been made in the steam-engine," and asked some "remuneration or relief" for Trevithick out of the public funds. The appeal, however, was never granted, and the petition became a dead letter.

During the remaining portion of his life, the career of the engineer was marked by restlessness and poverty, but with his genius for striking out boldly in new directions true to the last. At one time we find him in Holland absorbed in a plan for drainage, and with a view to double the land-surface of that country; at another he is engaged in designing a memorial to commemorate the passing of the Reform Act of 1832. To his erratic but original mind nothing appeared too costly or too large: not even a gilded cast-iron column, twice the height of the great pyramid! In connection with the latter idea various meetings of gentlemen were held in London, and the scheme was so far advanced as to be laid before the King, but within two months after his plans for the stupendous monument had been completed, the spirit of Richard Trevithick had passed away. Without a relative to nurse him in his last illness, he died on the 22nd of April 1833, penniless, and indebted for the last needful offices to some who had suffered loss by his schemes. A number of mechanics from the works of the Messrs. Hall, at Dartford, were the bearers of his coffin and the mourners at his funeral. His grave was dug at a spot allotted to the remains of the poor buried by the charitable, and the turf was replaced with no sculptured stone to mark the identity of the inventor's resting-place.

WILLIAM HEDLEY OF WYLAM.

THE merits of conspicuous labourers in the public service not unfrequently meet with full recognition and approval, while the achievements of others, who have been content to occupy less prominent positions in the same cause, are either wholly ignored or elicit but the scantiest acknowledgment. The history of invention furnishes many instances illustrative of the fact; not the least striking of these being associated with the construction of the Locomotive and the inauguration of the railway system. The success that ultimately attended the iron highway naturally arrested the attention of the world on behalf of the personal character, condition, and genius of him who had, by great energy and protracted perseverance, so largely contributed to the brilliant result. But the fame that accrued to the Killingworth enginewright tended to dazzle the minds of his countrymen, and to throw into the shades of neglect and obscurity efforts that might otherwise have been hailed with plaudits and rewards from a gratified and grateful nation. Perhaps of all the pioneers of the railway who suffered an injustice in this way, none deserved better treatment from their countrymen than did the mechanical engineer whose labours must now be noticed briefly.

William Hedley was born at the Tyneside village of Newburn, on the 13th of July 1779, and received his education under the care of a teacher named Watkins, whose school at Wylam acquired a good repute on account of the accomplishments and ability of its master. Hedley resembled the elder Stephenson in the inherent aptitude he displayed for mechanical experiments and pursuits, and in the application which he devoted to the great purpose of rendering steam locomotion something more than an ideal theory or problem, the practical solution of which was popularly considered as Utopian in the extreme. As engineers, both were self-taught too, but there the resemblance ceased, for Hedley possessed advantages in youth to which the son of the Wylam colliery-fireman could not lay claim during that important period of his life; and the former, born of well-to-do parents, received an educational and professional training that, added to his excellent natural parts and powers, fitted him in early manhood to assume a position of considerable trust and responsibility—first as the viewer of Walbottle Colliery, and afterwards at Wylam, in a similar capacity. Besides discharging, with conspicuous credit to himself and advantage to the owner, the functions which devolved upon him as a colliery manager, he soon embarked on his own account in ventures that enabled him to take a prominent part in developing the coal trade of the North, and to secure for himself and his descendants a social status of a desirable character. In the year 1805 he entered upon his duties at Wylam, so that his connection with the colliery was marked by all the efforts that were there put forth to make the Locomotive serviceable to commerce.

A few months before the removal of the young viewer to his new sphere, Mr. Christopher Blackett, the owner, gave an order to Trevithick for a locomotive capable of working the transit of coal upon the tramroad or waggonway leading from the colliery to the village of Lemington, some five

miles distant, where the freights of the waggons were put into barges or keels, and conveyed down the Tyne for shipment to London. One of the oldest in the North, the Wylam tramroad was then formed on the primitive principle of wooden spars or rails, and each chaldron waggon was drawn by a horse under the charge of a driver. So slow was the progression to and from the colliery, that each man and animal only accomplished two or three journeys daily. Having in 1803 seen Trevithick's engine in London, and become acquainted with the inventer, Mr. Blackett wished to test the capabilities of the new motive power, in order to ascertain whether its adoption would lessen the cost of haulage over the Wylam tramroad. Accordingly an engine was built, from Trevithick's plans, by John Whinfield of Pipewellgate, Gateshead—the foreman engineer being John Steel, who had previously been employed by the inventor in the construction of the locomotive for the Penydarran plateway. Referring to this first Tyneside locomotive, the following memorandum, by an experienced mechanic who was well-known in the North, may be read in the Patent Museum at South Kensington:—"Memorandum, May 1st, 1805. (Copy from R. W.'s Memorandums on Steam Engines.) —I saw an engine this day upon a new plan: it is to draw three waggons of coal upon the Wylam waggonway; the road is nearly level. The engine is to travel with the waggons. Each waggon, with the coals, weighs about 3½ tons, and the engine weighs 4½ tons. The engine is to work without a vacuum. The cylinder is 7 inches in diameter, 3-feet stroke, and is placed inside the boiler, and the fire is inside also. The speed they expect to travel at is from four miles per hour.—ROBERT WILSON." From one cause or another—probably the impression that it would prove too light for the required service—the engine did not leave Whinfield's works, but was separated from its wheeled carriage and used in blowing the cupola of the foundry.

About the year 1808, on the recommendation of Mr. Thomas of Newcastle-upon-Tyne, Mr. Blackett caused the wooden rails of his tramroad to be substituted by cast-iron plates, with the result that each horse-load was doubled—the increased work, however, necessitating the keeping of some spare horses for occasional relief. Thus a heavy charge was still incurred in the conveyance of the coal to the riverside, and increased economy in transit became a matter of considerable moment. At this time Trevithick was exhibiting his locomotive in the Metropolis, and it is highly probable that the owner and viewer of the colliery heard of the Cornish inventor's renewed attempt to bring the travelling-engine under the notice of the country, if either or both did not actually see the experiment in question. Be that as it may, Mr. Blackett wrote to Trevithick in 1809 regarding the construction of another locomotive, but the inventor stated in reply that, having declined that portion of his pursuits, and being then otherwise engaged, he could render no assistance in the furtherance of his correspondent's desire. Determined if possible to carry out his design, Mr. Blackett applied to the most eminent engineers of the period, but was informed that the idea of locomotive traction along a railroad was chimerical, and involved a physical impossibility should he attempt to carry it out. The result of the Penydarran trials being quoted in confirmation of the opinion thus expressed, the construction of an efficient locomotive was considered for a time as utterly hopeless by the enterprising owner of Wylam Colliery.

The long continuance of the war in which the country was involved, with the consequently high charges for all articles used in the working of the colliery, caused Hedley to be forcibly impressed by the necessity for promoting economy in the working expenditure under his management. Accordingly, in the year 1812, earnest attention to the subject led him to conclude that the outlay for convey-

ing the mineral to Lemington offered the only item in which a judicious saving might be effected, and he thenceforward continued to prosecute his efforts in that direction until these were crowned with the most gratifying success.

Hitherto the assumption had prevailed among engineers that the wheels of a locomotive, if entirely smooth, and placed upon even plates or rails, would have little or no grip of the line, and consequently would fail in the most important element of the engine's construction. It is true that Trevithick's locomotives for tramroad or railway service had smooth wheels, but there was no evidence that these had been tried on higher gradients than one in fifty, or that the trials had been with comparatively heavy loads; and the celebrated Cornishman's early opinion that some extraneous contrivance was necessary to ensure the required friction, *under all circumstances*, is evident from the following extract, taken from a copy of Trevithick and Vivian's specification of the year 1802:—"It is also to be noticed, that we do occasionally, or in certain cases, make the external periphery of the wheels uneven, by projecting heads of nails or bolts, or cross-grooves, or fittings to railroads when required; and that in cases of hard-pull we cause a lever, bolt, or claw to project through the rim of one or both of the said wheels, so as to take hold of the ground; but that in general the ordinary structure or figure of the external surface of these wheels will be found to answer the intended purpose." The undulating nature of the Wylam waggonway rendered it absolutely imperative that the tractive power of a tramroad locomotive with smooth wheels should be accurately demonstrated, so that the engineer might be able to determine whether the travelling-engine could be adopted by him with advantage under the circumstances. In prosecuting his experiments to that end, Hedley had a strong incentive in the fact that others, about this time, were endeavouring to effect locomotive improve-

ments, but in a direction contrary to that which he conceived would lead to a practical solution of the friction problem; a question which had led men so wildly astray in their notions regarding the utility of steam traction for commercial purposes.

In 1811, Blenkinsop of Middleton had patented a travelling-engine, the prominent feature of which lay in its toothed wheel working into a rack rail in the centre of the line. An alteration was afterwards adopted; one of the side rails being toothed for the reception of the corresponding wheel, upon which depended, as was then supposed, the progressive power of the machine. The great friction and additional cost caused by the appliance, however, prevented the existence of any sanguine hopes as to the alteration proving successful, either in a mechanical or pecuniary sense; and the patent was at length abandoned as valueless. Another so-called improvement, devised by Chapman of Newcastle, consisted in a chain along the railway, into the links of which the toothed wheels of the locomotive passed while travelling, so as to further the adhesion of the carriage wheels to the rails; but the frequent breaking of the chain caused this experiment also to be regarded as unsuccessful. Brunton's engine, invented about the same time, and designed to be assisted in its progress by legs set in motion by the machinery, was likewise declared to be abortive, though ingenious in construction and idea. In all these instances the inventors had proceeded upon the hypothesis that smooth wheels upon smooth rails would be insufficient to ensure the progression of the engines when attached to moderately heavy loads, and William Hedley set himself the task of proving demonstratively the absurdity of the assumption.

Before commencing his experiments, the Wylam viewer caused a number of underground carriages and rails to be sent to the neighbourhood of his house, where a temporary

railway was laid down for the purpose. Finding the preliminary trials in some measure satisfactory, he resolved to conduct his further operations with as much secrecy as possible, in order, doubtless, to prevent the prying curiosity of his neighbours from conducing to forestall him in his object. Accordingly he carried on the most of his practical researches into the adhesive principle of wheeled carriages at midnight, and with the result that absolute confirmation was given to his opinion—namely, "that if the wheels of an engine-carriage were connected, it would, *by the friction of the wheels upon the rails, induced by its gravity alone, be enabled to overcome the resistance presented by an attached train of carriages.*" Hedley communicated his conclusion to Mr. Blackett, who expressed surprise and pleasure at the prospect thus held out of steam locomotion becoming available on the colliery waggonway; but the owner being very desirous of seeing for himself a repetition of the experiments, it was agreed that a short line of railway should also be laid in Mr. Blackett's grounds, where a succession of trials put the question beyond the pale of uncertainty, for Hedley's theory was again unequivocally strengthened and confirmed. Mr. Blackett thought that a locomotive ought to be constructed without unnecessary delay, but Hedley considered there was an important point yet to be decided, and one that his experiments with the small underground trucks had not enabled him to ascertain—namely, Was there no reaction? The doubt that existed in the mind of the viewer was one suggested by the engineering theories of the time, and Trevithick's abandonment of the Locomotive had done not a little to raise misconceptions regarding the causes which had contributed to that circumstance. Previous therefore to incurring the responsibility of building a locomotive upon a principle which had been declared unsound by competent authorities, Hedley resolved to renew his experiments upon a larger scale, and to leave

the construction of a locomotive, or the rejection of the proposal, to be decided by the issue of the succeeding trials. These experiments were carried out upon the Wylam waggonway, and have been detailed by the son of the skilful, though amateur, mechanical engineer. Mr. Oswald Dodd Hedley, in a critical treatise, entitled, *Who Invented the Locomotive Engine?* says:—

"In October 1812, a carriage was constructed and placed upon the railway. It had four wheels, and was made of sufficient strength to allow of an engine being placed upon it, if the experiment proved satisfactory. To prevent independent action of the fore and hind wheels of the carriage, they were connected by five teeth-wheels. Either three or five may be used for the purpose, depending on structural arrangement. This effectually insured co-operation of movement; for if the movement of one pair of wheels be progressive, the other must be progressive also; or if one pair surge or turn round upon the rails without advancing the carriage, the other pair must of necessity move in the same way; the gross weight of the carriage being brought in aid of the operation, as if it had been supported on one pair of wheels only.

"Various parcels of iron, of ascertained weight, were placed upon it. The progressive motion of the carriage was affected by the application of men at the four handles, of which there were two at each side of the carriage, and in order that results might not be affected by the reaction, if such obtained, of the men operating from the ground, four stages were suspended from the carriage for them to work from. Their weight had also been ascertained previous to the experiment.

"The experimental carriage was now equivalent to one having an engine placed upon it, the usual motive power, steam, in this case being represented by the muscular force of the men at the handles, of whom there were two at each; in all, eight. Occasionally the number was increased, varying from eight to twelve. Two, three, four, five, or more waggons were attached to it, and the proportion that obtained between the weight of the experimental carriage (for everything had been weighed or estimated) and the coal waggons, at that point where the wheels of the former surged or turned round upon the rails without advancing, was ascertained. A number of men got on to the carriage. At a signal they jumped off, upon which the wheels turned round while the carriage ceased to advance. The weight of the carriage, the number of waggons, the motive force, were all repeatedly varied. The

stages even were removed, the men now working from the ground, but with the same relative results.

"This experiment, which was conducted with great care, was as rigid as it could be made. It was tested with great determination of purpose also, for the trial extended over the whole line, commencing at the colliery and terminating at the river, a distance of five miles. The result of the experiment indicated that the friction of the wheels of the experimental carriage alone upon the rails, when it approached to the weight of an engine-carriage, was sufficient to enable it to overcome the resistance of an attached train of carriages. For a distance of two miles I watched this interesting and ingenious experiment—this great achievement by which Mr. Hedley, standing alone and in opposition to the entire engineering talent of the country, determined and established upon a sure basis the true principle of locomotion—namely, the engine-carriage acting by its gravity alone upon the rails. I recollect Mr. Hedley saying, on the evening of the day the experiment was made, that he had saved the colliery; and on the day following, in the colliery office, Messrs. Blackett and Hedley congratulated each other on the certainty that the coals would now be conveyed by iron-horses."

The result of these experiments being conclusive and satisfactory, it was determined to construct an engine upon the experimental carriage for service on the waggonway, but Hedley had now to meet the difficulty common to the early builders of locomotives, caused by the scarcity of skilled mechanics that then existed. The colliery workmen being unable to carry out such an unusual undertaking, the viewer engaged the services of Thomas Waters, a mechanical engineer of Gateshead, for the construction of his first travelling-engine, which was completed in about three and a-half months, after much displacement and replacement of the parts during the progress of the work. The engine had one cylinder six inches in diameter, and a fly-wheel. Through the boiler of cast-iron passed a longitudinal tube containing the fire; the chimney being situated at the end farthest from the furnace, and in that respect differing from Trevithick's earlier locomotives, which had return, or breeches tubes, and were fired from the end from which

the chimney protruded. According to the popularly received version of the story, the handiwork of "Tommy" Waters and his assistants flew in pieces, to the imminent danger of all who had been concerned in the building of the engine. It should be noted, however, that a circumstantial denial has been given to that statement by Mr. Hedley's son, in the treatise from which we have just quoted; and in the following narration of incidents connected with the Wylam locomotives, adherence is mainly kept to Mr. O. D. Hedley's relation of the circumstances.

Early in the year 1813, William Hedley's first locomotive, with six loaded trucks attached, began running on the colliery tramroad. On the more level portions of the line the machine went fairly well, but the deficiency of steam-pressure caused it to come to a standstill at the heavier gradients of the road. In short, the stoppages were frequent, but the inefficiency of the engine was rather to be attributed to the inadequate supply of steam, than to defects in the working gear. Under the most favourable circumstances its speed did not exceed the rate of five miles an hour, while the haulage-power of the locomotive was only that of three horses.

Popular sympathy in the neighbourhood was adverse to the success of "Puffing Billy." Whole families were interested in the working of the waggons by horses for their daily bread, and continued residence in the village depended in no small measure thereon. The mining population deprecated the use of such machinery. Even colliery officials had wagered that the engine would prove a failure, and there were few persons in the immediate locality who would not have hailed its abandonment with satisfaction. It may be assumed there were only two individuals who had absolute faith in the superiority of locomotive over animal traction being ultimately established, and these were the energetic owner of Wylam Pit and his talented manager.

But apart from Puffing Billy's defects, and the existing popular animus, another annoyance to Messrs. Blackett and Hedley was found in the formidable opposition raised by the way-leave proprietor to the progress of the engine through his property. As it was impossible to make any deviation in the line of the tramroad that would have obviated the proprietor's objections in the matter, this came to be one of the most serious obstacles to be overcome, for the very existence of the mine was jeopardised by the caprice of the landowner. Besides, the tramroad had not originally been intended for traffic by means of steam locomotion, and was consequently but ill-adapted for the purpose. From various quarters came the advice to abandon the project. The engineer, however, remained firm in his determination. He had satisfied himself of the soundness of the principle upon which he was acting, and he therefore resolved that, come what might, he would persevere until his success was unqualified and assured. When tho fate of steam locomotion on the old Wylam waggonway thus trembled in the balance, William Hedley found considerable satisfaction in the fact that Mr. Blackett never wavered in his faith towards the object upon which the desires and efforts of the viewer had been centred while engaged in the preliminary experiments.

In spite of the dubious efficiency of the first locomotive, its daily performance on the line had never given occasion to its enemies to call in question the important principle of locomotion that underlied its construction—namely, the power of progression through the friction caused by the weight of the engine and its carriage upon the surface of the rails. Its defects were clearly traceable to defective force in the motive power, and with a view to remove these defects, or reduce them to a minimum, the engineer proceeded with the plans for a second engine, capable of generating steam at a pressure higher than was under the

circumstances attainable by the first locomotive built under his direction.

In the construction of his second locomotive, Hedley had to grapple with the necessity for lightness in the engine and carriage, so as to prevent the breakage of the plate rails when travelling: an inconvenience which had frequently resulted from the excessive heaviness of his first engine upon the weak rails of the tramroad. These rails were of cast-iron, and only weighed 36 lbs. to the yard, so that the strength of the line was not adapted to sustain a much greater bearing stress than that of a loaded waggon drawn by a horse. To ensure, therefore, as much lightness as possible, a thorough revision of the mechanical arrangements in the new locomotive was urgently demanded. An increased supply of steam being also required, it was essentially necessary that a radical change should be made in the structure of the boiler—the single-tube principle having been proved by the engineer to conduce to very great disadvantages. These were a rapid abduction of heat to the chimney, an inadequate supply of steam, and a large consumption of the best coal in firing the engine, as inferior descriptions of colliery produce were found to be unserviceable for the purpose.

The necessity of an increased supply of steam formed a subject of considerable anxiety to the engineer, and the adoption of one of the following alternatives appeared to him as offering the readiest way out of the difficulty: first, the return tube, similar to that we have seen in Trevithick's locomotives; or secondly, a double return of the tube after traversing the length of the boiler, thus making two flues for the return instead of one. After much anxious consideration, Hedley determined to have an oval flue, with a single return through the boiler, as that form of tube "would concentrate the heated products of the furnace, causing them to give off their heat from the extended space they had to traverse in their passage to the chimney, with-

out interfering with that part of the tube containing the fire." In consequence of the local workmen not undertaking this portion of the work, the tube was made by a skilled artizan named Parker, who was employed at the Tyne Iron Works, Lemington. The other portions of the locomotive were wholly produced at the colliery workshops, and Mr. O. D. Hedley describes the improved efficiency attained by the machine when completed, as follows:—"The boiler of this engine was of malleable iron. The fire-tube was enlarged with a return flue, having the chimney at the same end of the boiler as the furnace. This return or double flue was the first great improvement in the second engine, without which it never could have travelled on that heavy line, the Wylam Railway. This engine was placed on four wheels, and went well. After the roughness had worn off, it drew eight loaded waggons at the rate of nearly five miles per hour. Matthew Nicholson, who wrought on the railway from 1807 to 1830, states that, in about six weeks after it commenced work, it drew regularly and well ten waggons at the rate of five miles per hour, travelling with the empty carriages about six miles and a-half, and doing the work of ten horses as it travelled on the line."

Not only was the performance of the second locomotive highly satisfactory, but the economy effected in the firing of the boiler formed a ground of considerable gratification to the engineer, as the fuel used in generating steam was now of the commonest description—the use of the best coal not being, as formerly, a necessity. But the satisfaction experienced by Hedley and the adventurous owner of Wylam Colliery at these results was not unalloyed, for the use of the travelling-engines had raised a formidable opposition to the innovation, which may be best described in Mr. O. D. Hedley's words:—

"One circumstance connected with the establishment of the locomotive engine should be mentioned. From the day the first engine went

down the railway, the proprietor of a way-leave ceased not to complain of the great annoyance arising from the smoke, and from the noise the exhausted steam made on being discharged into the atmosphere. I can also speak to the circumstance of the expended steam wetting the railway very much. In constructing the second engine, for the two-fold purpose of preventing the noise and of making the smoke less objectionable, a chamber was placed on the boiler, into which the eduction pipe conveyed the expended steam from the cylinder, whence it was discharged in an expanded state into the chimney (through the medium of a pipe connected to the chamber and the stack). When the engine was constructed, this pipe was of uniform size throughout, with its end vertical in the chimney for about six inches, which not only prevented the noise of the steam, but produced another effect—the blast developed itself; many persons say that from the first it was apparent the chimney draught was increased. I have also been told that the pipe got furred, or partially choked, and when the obstruction was removed it was found that steam could not be generated so rapidly; and that to increase the supply, the drivers, by means of an iron ring, contracted the orifice of the pipe, and kept it secret for some time. However, Mr. Hedley had the end of the upturned pipe contracted, but not to such an extent as to annoy the way-leave proprietor, whose residence stood on a rising ground some distance from the railway, and from this time there was no want of steam in these engines. Corroborative of this and other statements, I have written evidence before me from individuals who were well acquainted with the circumstances.

"Commencing with the second engine, with its return flue and upturned pipe in the chimney, the Wylam engines improved in a surprising manner. In about two years from the time the first one was placed on the railway, they conveyed sixteen waggons at the rate of upwards of five miles per hour; with the carriages empty from six to seven, and doing the work of sixteen to eighteen horses, as they travelled on the line. The engines continued doing this extraordinary amount of work for several years; but the resistance which so many carriages presented laid a very heavy strain upon these small engines, and the number was subsequently reduced to twelve, arrangements being made for obtaining carriages with greater facility at the termini of the railway, the engines also travelling faster. After the orifice of the pipe in the chimney had been contracted, the sparks frequently flew out with such velocity as to set the hedges and grass on fire in the summer time; and on one occasion, in the year 1825, they ignited a fine hedge. The occupier of the property came with a fowling piece, and

threatened to shoot the drivers, who were so alarmed that they refused to go down with the engine, and a person had to go down from the colliery and appease the wounded feelings of the party, or, as it was termed, to make peace. Shortly after this a stack of corn standing at some distance from the railway, in the Newburn Half Acres, was also set on fire by the issuing sparks. It was at Wylam, in the small chimney, that the value of the blast was ascertained, and not elsewhere.

"To further conciliate the way-leave proprietor, two fixed points were determined upon, between which firing was disallowed, both on the outward and homeward journey, thus putting the engine on good behaviour in front of his house. This to some extent had the desired effect. I only touch slightly on the subject of the way-leave; but it was a long and very serious affair, extending over a number of years, and at one time it caused great alarm for the fate of the engines. Even after they were established, this part of the line had occasionally to be worked by horses."

In the year 1813, a patent was granted to William Hedley for his improved travelling-engine, but it does not appear that the patentee ever reaped any pecuniary advantage from the concession thus made to his engineering skill. He had however established for the Locomotive the soundness of the principle of adhesion by gravity; at a time, too, when the efforts of other engineers were directed into dubious channels for the solution of a problem that only required the right application of a natural law to remove it from the sphere of question or debate. As early as 1815 the Wylam engines were doing work equivalent to that performed by sixteen or eighteen horses, and from that time may be traced a new era in the history of steam locomotion and the iron highway.

The Clarence Railway was projected about the year 1824, for the purpose of giving facilities of transport to the colliery-owners of South Durham, and Hedley gave evidence before the Parliamentary Committee in support of the Bill of the promoters. The measure received considerable opposition from the Stockton and Darlington Railway Company, but eventually passed the Legislature in 1828, and the line

was constructed. The Wylam engineer was now largely interested in the South Durham coal trade, and it is said that for three years the only traffic over the Clarence Railroad was from Hedley's collieries to the river Tees, where the line terminated; the rolling stock being provided by the owner of the mineral thus conveyed. In 1835 the first locomotive was placed upon the line, an earlier use of the iron-horse having been denied to him who had done so much in the interests of others to make steam locomotion available for the transport of coal to the shipping staith. Hedley's South Durham locomotive was named the "Tyneside." It was the second engine built with the four fast eccentrics for the reversing motion, and was constructed at what has become the celebrated factory of the Messrs. R. & W. Hawthorn, Newcastle-upon-Tyne.

During the remainder of his life Mr. William Hedley was largely interested in the coal trade of the North, and he therefore left to others the work of improving the Locomotive, which he had so successfully initiated and carried on at Wylam. But his labours for the development of Steam Locomotion were highly meritorious, and the results of his dogged energy and mechanical skill contributed not a little to the ultimate triumph of the Railway System. He died at his residence, Burnhopeside Hall, near Lanchester, on the 9th of January 1843, and his remains rest near the old waggonway that witnessed his experiments and demonstrated the importance of his achievement.

TIMOTHY HACKWORTH.

THE difficulties that beset the early inventors and improvers of the Locomotive received, as we have seen, considerable force from circumstances induced by the great scarcity of competent mechanics. It is true that here and there individual artizans exhibited a more than ordinary faculty for mechanical construction, but the ingenuity displayed by these representative forerunners of the engineering trade—a handicraft that has now assumed gigantic proportions—were rather inherent to the mental constitution and tastes of the men than acquired by regular courses of training in the workshop or factory. The number of trained workmen engaged in engine-building kept, for many years, at a tardy pace behind the demand for their services, and it was only when Steam Locomotion had passed out of the region of questionable utility, and had assumed an unassailable point in public estimation, that skilled hands were found to be sufficiently numerous in the country to carry out, with any marked degree of efficiency or speed, the designs of inventors who had devoted their lives and talents to locomotive improvement. Timothy Hackworth, whose efforts contributed in no mean degree to the universal adoption of steam traction on railways,

profited largely by his servitude as an apprentice in the engine shop at Wylam Colliery; for to the practical experience thus gained, as well as to his natural aptitude for the employment which had been selected for him, may be attributed the success that rewarded his industry when a mechanic, and the distinction which he attained as a mechanical engineer and director of skilled labour.

Like his friend George Stephenson, Timothy Hackworth was born in the Tyneside village which has become historically associated with the invention of the Locomotive and the birth of the modern railway system. Timothy's father, John Hackworth, was the foreman blacksmith at Wylam Colliery, and he filled that situation, it is stated, with creditable ability. He also earned some local reputation as a boiler builder, while the study of mechanical principles and contrivances not only afforded him considerable pleasure, but it enabled him to spend his leisure hours in a manner profitable to himself and serviceable to his son. Timothy made his first appearance upon the stage of human existence on the 22nd of December 1786, and in his younger years gave evidences of his strong liking for the forge and all its accessories. At the village school, the boy received an education that in those days was considered quite a superior one by members of his order, and letters written by him in manhood, during the battle of the Locomotive, show that the schooldays of the engineer were not passed in sluggish indifference to the pursuit of knowledge.

Young Hackworth evinced at an early age a decided partiality for mechanical studies and experiments, and his father fostered and encouraged, by all available means, tastes that were so much in harmony with his own, until the lad had attained the age of fourteen, when he was apprenticed as a blacksmith to the owner of the colliery, and the paternal care was further exercised by the desire to give the son a practical acquaintance with a handicraft that

perhaps than all others was the better fitted to prepare him for filling satisfactorily the onerous position to which he was afterwards called, as a mechanical and consulting engineer.

At the age of sixteen the apprentice blacksmith found himself fatherless, and with the largest share of the family burden resting upon his own youthful shoulders. But he was strong, willing, and hopeful of the future, and he resolved to do his duty towards his widowed mother and her children to the best of his ability. So satisfied was the manager of the colliery with his conduct that, on the termination of his apprenticeship in 1807, he was appointed to the situation from which death had removed his father five years before; and he took an active and intelligent part, under Mr. Hedley the viewer of the colliery, in all the preliminary experiments, as well as in the building of the Wylam locomotives.

Hackworth's connection with this colliery terminated in the year 1818, when he removed to Walbottle, in the same neighbourhood, and entered upon an engagement in a similar capacity, which he continued to fulfil until the inauguration of the railway system brought him to the front as a mechanical engineer, and gave scope for a better exercise of his talents and skill. In 1824, George Stephenson was engaged to survey the proposed route of the Liverpool and Manchester Railway, but a difficulty arose as to the management of the engine works at Forth Street during the absence of the principal of the firm. In the emergency Hackworth was solicited to take charge of the factory, and he did so, with the consent of the manager of the Walbottle Colliery. Having discharged his duties at Newcastle in a most efficient manner, and won the approval of Stephenson, the engineer was pressed to continue his services as manager of the Forth Street Works, with a partnership in the firm of Robert Stephenson and Company.

The offer, however, was declined by Hackworth, for what reason has not been stated. About the same time a proposal was made to him to undertake the direction of an exploring expedition to Venezuela, Trinidad, and New Granada, but the negotiations were brought to a close by the resolution of the engineer to spend his life in the country of his birth. In all probability the strongly defined religious instincts of the engineer, who was a lay-preacher of the gospel, led him to shun a protracted contact with the undevotional manners and course language of the careless spirits who usually form the rank-and-file of a party of exploration.

After leaving the Forth Street Works, Hackworth was engaged for a short time in the building of engine boilers for the Tyne Iron Company, but having determined to begin business upon his own account, he hired premises for that purpose. Before entering on the occupation of these, however, he was solicited by George Stephenson to accept the appointment of resident engineer of the Stockton and Darlington Railway, a position that he assumed in June 1825, three months previous to the opening of the line for traffic. In his new sphere he soon earned the respect and confidence of his employers. The first public railroad had been laid, but there still remained to be completed numerous details connected with the prospective working of the line, and to the discharge of the duties thereby involved, Hackworth was able to bring a large share of natural shrewdness, mechanical skill, and undeviating integrity and application. Before him stretched a congenial field for his industry and ingenuity, and these were not allowed to become rusty through lack of opportunity for their exercise.

We have already noticed the difference of opinion that prevailed among the early promoters of public railways as to the most efficient or economical traction of the carriages. While stationary engines and locomotives had their several

partizans and advocates, the old-fashioned horse-power received strong support from a section of projectors whose proclivities were adverse to newfangled ideas or improvements of a questionable order. The relative value of fixed engines and horses for the purpose required was, comparatively speaking, clear and definite. The Locomotive, on the contrary, was now to be placed upon its trial, and its efficiency scrutinised by the public generally, as well as measured by the results ascertained by the actual cost incurred in its use. With the prescience of a man considerably in advance of the period and its mechanical acquirements, Hackworth felt that the iron-horse was adapted for improvements of the most extensive character, and that radical alterations in its construction were urgently needed ere its superiority as a motive power could be fully established and assured. To the accomplishment of that idea the resident engineer of the Stockton and Darlington line devoted the best years of his life.

For some time after the formal opening of the first public railway, horses were employed not only in the conveyance of passengers, but in the transit also of minerals and merchandise; and a comparison of the outlay for the two methods of haulage, it is stated, gave but a slight advantage in favour of the locomotives over the animal power. It has been also affirmed that the frequent repairs needed in the travelling-engines caused the abandonment of the machines to be seriously entertained by the directors. However, the fate of the travelling-engines was held in abeyance at the solicitation of Hackworth, who undertook to construct an engine, from his own plans, that would prove superior to any locomotive hitherto built, and suitable for the requirements of an increased traffic over the line. To the permission granted to the engineer to carry out this design was annexed the condition that he would utilise the boiler of a discarded engine, and the construction of Timothy

Hackworth's first and improved locomotive, the "Royal George," was at once proceeded with, and duly completed; the result amply confirming the accuracy of the calculations of the engineer and the soundness of the mechanical principles which had guided him in the contrivance and workmanship of the engine. The following comparison, given in the *Practical Mechanics' Journal*, vol. iii. p. 49, is interesting as a record of the advantage gained by Hackworth for the iron-horse at a most critical juncture in its history:—"Cost of 'Royal George,' £425; number of tons conveyed by her in one year, 1828, 22,442 tons over twenty miles; cost of conveyance, one farthing per ton per mile, or, including all repairs and maintenance, and interest on sunk capital at ten per cent., £466: an economy in working which is rarely exceeded at the present day, *after a lapse of twenty-three years.* The cost of the same work performed by horses was £998, showing a difference of £532 in favour of the engine over the animal power."

In the building of this engine Hackworth departed from the old lines of locomotive form, and gave a new appearance to the machine by altering the two upright cylinders working on separate shafts. In the "Royal George" the cylinders were inverted and placed on opposite sides of the boiler. Discarding as inefficient for his purpose the single fire-tube adopted by Blenkinsop and George Stephenson, he employed for the firing of the boiler the return tube devised by Trevithick, and embodied by Hedley in the Wylam locomotives. By ejecting the waste steam through the contracted orifice of the waste-pipe in the chimney, the force of the blast was greatly augmented, and the rapidity of combustion in the furnace thereby accelerated. Hackworth's improved blast-pipe gave a speed and power to the Locomotive not hitherto attainable. The engine also contained improvements in the short-stroked force-pump, and adjustable springs for the safety valves; the latter contrivance

being substituted for the hanging weights formerly used for controlling the pressure of the steam. The overhead gearing being abolished, a more direct and increased force was employed in the driving of the six coupled wheels upon the rails, and the adhesion necessary for the progression of the engine and its load was thus considerably furthered and secured. The "Royal George," of the year 1827, was the parent of a new race of iron-horses, but much remained to be accomplished ere the Locomotive advanced perceptibly in public favour.

In the year 1828, the question of the motive power to be used upon their railroad engaged the urgent attention of the directors of the Liverpool and Manchester company, and a deputation was sent to the North for the purpose of inquiring into the results afforded by the use of locomotives on the Stockton and Darlington line, and the colliery railways in the vicinity of Newcastle-upon-Tyne. On its return to Liverpool, the deputation reported that there were strong reasons against the employment of horse-haulage on public railways, but declined to decide definitely regarding the superiority of stationary or travelling-engines. It was therefore resolved that the respective merits of the two kinds of engines should be submitted to the arbitration of the Messrs. Rastrick and Walker, and these gentlemen, as we have noticed, declared against the locomotives, and in favour of fixed engines. That decision was a severe blow to the Stephensons, for the Liverpool directors could not ignore the deliverance made by the engineers consulted, and the abandonment of locomotive construction at the Forth Street Works—a result of the most likely character, had the directors given full effect to the report of the engineers—would have entailed serious losses upon the firm, by the nonfulfilment of the purpose for which the factory had mainly been established. In the emergency thus created, Robert Stephenson applied to the Stockton

and Darlington resident engineer for his advice and assistance, with a view to confute the unfavourable opinions of the Messrs. Rastrick and Walker, and remove impressions that were calculated to retard, if not arrest, the progress of railway enterprise. On the 17th of March 1829, the younger Stephenson wrote to Hackworth as follows:—

"The reports of the engineers who visited the North to ascertain the relative merits of the two systems of steam machinery now employed on railways, have come to conclusions in favour of stationary engines. They have increased the performance of fixed engines beyond what practice will bear out, and I regret to say, they have depreciated the locomotive engines below what experience has taught us. I will not say whether these results have arisen from prejudice, or want of information, or practice on the subject. This is not a point which I will presume to discuss. I write now to obtain answers to some questions on which I think they have not given full information. Some of their calculations are also at variance with experiments that have come under your daily observation. For instance, they state it positively as their opinion, that a locomotive engine of ten horse-power, or say of the usual size, will not convey more than ten tons, exclusive of the waggons, at the rate of ten miles per hour in winter time, and in summer the same engine will take thirteen and a-half tons. The calculation is made on the assumption of the road being level. In answer to this statement, will you be kind enough to state at what speed *your own engine* returns from Stockton with a given number of empty waggons, and the rates of ascent? The whole ascent will do to get an average. State also at what speed the six-wheeled engine made by R. Stephenson & Co. will return with any given number of waggons. What load, including waggons, will an engine weighing nine tons, including water, take at the rate of ten miles an hour on a well-conditioned railway? Let it be understood that all your statements are made under the supposition that the speed is to be maintained for twenty or thirty miles without stopping, except for water. Let me have your general opinion as to the locomotive engine system. Is it as convenient as any other? Would you consider thirteen and a-half tons in summer, and ten tons in winter, a fair performance for a good locomotive engine? You will oblige me much by answering the above questions as promptly as possible, as the discussion on the merits of the two systems is yet going on amongst the directors here."

Hackworth's reply to the interrogatòries of the younger Stephenson was characteristic of the man. Clear, concise, and comprehensive was the opinion which he rendered in regard to a matter that had greatly puzzled the minds of the most eminent mechanical authorities, and had brought the deliberations of shrewd men of business almost to a standstill. Time has amply verified the truthfulness of the predictions contained in the following extracts from the letter to Robert Stephenson:—

"The statement you allude to, that a complete locomotive will take but ten tons at ten miles per hour, is quite at variance with facts; as an opinion merely, this I would forgive. Four of our waggons, laden for depôts, frequently take from twelve to thirteen tons of coal, exclusive of the waggons. Our engines never take less than sixteen laden waggons in winter, and in summer from twenty to twenty-four and thirty-two laden, and can maintain a speed of five miles per hour, except in case of stoppages by means of horse waggons at the passing places. Engines thus loaded have frequently travelled at nine miles per hour, sometimes more. It is unsafe to aim at speed on a single line of railway; the danger is at the passing places. I am verily convinced that a swift engine upon a well-conditioned railway will combine profit and simplicity, and will afford such facility as has not hitherto been known.

"I am well satisfied that an engine, of the weight you mention, will convey on a level, in winter, thirty tons of goods ten miles per hour, exclusive of carriages, and forty tons in summer, exclusive of carriages. The six-wheeled engine, fitted at the company's works, generally takes twenty-four waggons, 53 cwt. to three tons of coal each, speed five miles per hour, empty waggons 24 cwt. each; the six wheels, by R. Stephenson & Co., twenty waggons, five miles per hour, weight as above.

"As to my general opinion as to the Locomotive System, I believe it is comparatively in a state of infancy. Swift engines upon a double way, I am convinced, may be used to the utmost advantage. Improvements upon anything yet produced, of greater importance in all respects, are clearly practical; and I am sure this will prove itself by actual remuneration to such parties as prudently, yet diligently, pursue the execution of this kind of power, with their eyes open to those alterations and advantages which actual demonstration of local circumstances point out.

"Stationary engines are by no means adapted to a public line of railway. I take here no account of a great waste of capital. But you will fail in proving to the satisfaction of any one not conversant with these subjects the inexpediency of such a system. . . . I hear the Liverpool company have concluded to use fixed engines. Some will look on this with surprise; but as you can well afford it, it is all for the good of the science and of the trade to try both plans. Do not discompose yourself, my dear sir: if you express your manly, firm, decided opinion, you have done your part as their adviser; and if it happen to be read some day in the newspaper, 'Whereas the Liverpool and Manchester Railway has been strangled by ropes,' we shall not accuse you of guilt in being accessory either before or after the fact."

Having already described the circumstances that conduced to the competition of locomotives at Rainhill, as well as the failure on that occasion of Hackworth's engine, the "Sanspareil," we need not enter more fully into the probable causes of that failure. It should be noted, however, that the engineer laboured under many disadvantages in the building of the "Sanspareil," not the least of which were occasioned by the want of facilities for making the boiler and cylinders under his own eye; and without calling in question the finding of the judges after the trial, we may state that engineering critics have subsequently declared Hackworth's locomotive to have been, in some essential respects, superior to all its rivals in that competition, and on the whole not much inferior to the successful "Rocket." In his treatise on *Steam Boilers*, Mr. Armstrong pointedly remarks:—"The original 'Sanspareil' of Mr. Hackworth, which all but successfully competed for the prize at the opening of the Liverpool and Manchester Railway, may still be seen regularly working on the Bolton and Leigh Railway, apparently not much worse for *seven years'* constant work, the boiler never having required any essential repair, while its contemporary rivals that have escaped the fate of the 'scrap heap,' have been re-made and mended over and over again since the celebrated race at Rainhill; a fact

which goes far to prove that the principle of this engine has not been so very much improved upon, except that it is not so well calculated for burning coke as coal." The "Sans-pareil" now occupies a position in the South Kensington Museum, beside "Puffing Billy" and the "Rocket;" all being interesting relics of the mechanical ingenuity that emanated from a humble colliery village on the banks of the Tyne.

The disappointment experienced through the result of the Rainhill competition rather stimulated Hackworth to make further improvements in the Locomotive than led him to fall into a condition of listless depression, for, during the remainder of his active and useful life, that object gave employment to a large share of his thoughts and energies. About the year 1834 an alteration was made in the terms of his connection with the Stockton and Darlington Railway, whereby the traction of the traffic over the line was placed in his hands under contract; while liberty was reserved to him to act as a consulting engineer in a private capacity. The remarkable success that attended his efforts to improve his locomotives may be illustrated by an opinion expressed regarding those on the Stockton and Darlington Railroad after a lapse of twenty years. Take them weight for weight, they surpassed any engine on the line. The engineer died in the sixty-fourth year of his age, after a career that reflected conspicuously the most attractive phases of the Christian character, as well as the possession of natural and distinguished mechanical genius.

ISAMBARD KINGDOM BRUNEL.

IN the lives of George and Robert Stephenson one characteristic stands prominently forward as the guiding principle or motive that actuated or controlled all their aims and efforts as railway engineers. An almost extreme caution was invariably manifested by the distinguished father and son, both as to the utility and stability of the structures they reared, and the reasonable expectancy held out of a profitable return to the shareholders in the several projects that engaged their attention from time to time. Even when the great railway mania was at its height, the speculative fever that affected so many of their contemporaries was incapable of dulling their senses to the necessity of scrutinising the pecuniary prospects of an undertaking as well as its engineering feasibility and value. Briefly, the Stephensons attached more importance to the sound position a scheme might attain upon the Stock Exchange than to any merit that might accrue to themselves through the successful accomplishment of great constructive designs. In that respect at least they may be regarded as having followed professionally a practice directly the reverse to that of the Brunels. To both of the latter famous men an engineering triumph had a fascination that tended to

Isambard Kingdom Brunel.

obscure any ruinous results that might be thought to be coincident with a splendid victory over Nature and her forces. The Stephensons were skilful and ingenious, practical and shrewd. The Brunels, original and daring, idealistic and ambitious. The former father and son may be justly regarded as true representatives of the English school of engineering; the latter as bold exponents of the Continental. In concluding the present record of the work and worth of the early railway engineers, we can only give but the merest outline of the achievements of the distinguished pioneer of express speed upon passenger engines.

The son of a civil engineer of considerable distinction, Isambard Kingdom Brunel was born at Portsea, on the 9th of April 1806. His father, Sir M. Isambard Brunel, possessed natural endowments of a high order, and these were largely inherited by young Brunel, and exhibited throughout his remarkable life. When a boy his powers of observation and reasoning were keen and accurate, and may be illustrated by an anecdote relating to his schooldays. When about twelve years old he was being educated at Brighton, and immediately opposite the school-house there were some buildings in course of erection. As the operations progressed, the lad noted attentively the negligence of the workmen, and the slovenly character of the work. One evening the darkening of the sky by the heavy masses of clouds that gathered overhead, together with the existence of a stiffish breeze that threatened to blow ere long with the strong energy of a gale, directed the contemplation of Isambard to the weakness of the buildings across the way, and the little likelihood there was of the unstable structure braving successfully the force of the rising blast. Having arrived during his cogitations at the latter conclusion, he at once challenged the opinions of his companions on the subject, and offered to pay a penalty for miscalculating the relative strength of the elements and the building in question

should the fall of the latter during the night not take place. The proposal of a wager on these conditions having been accepted by one of his schoolfellows, Isambard was early astir on the following morning to prove the correctness or the reverse of his prognostications. Looking in the required direction, he found that the fragile walls had been levelled with the ground, and that he had won his wager.

To complete his education young Brunel was removed from the Brighton academy to Paris, where he received instruction under M. Massin; classical literature claiming a large share of attention, much to the mortification and annoyance of the student. After an interval spent in the study of the classics, he entered the college of Charlemagne, better known as the Lycée, where he remained during two years, and followed courses of learning that were to him of the most pleasurable kind. Here his progress was rapid and successful, for during his curriculum he took first prizes respectively in mathematics, history, geography, and French. He also gained a second prize for drawing—an accomplishment that was to prove of advantage to him in his future profession.

In the year 1822 he returned to England and entered his father's office, where he received his initiatory training for the profession of a civil engineer. The duties that he was now called upon to fulfil were congenial to his nature and disposition, and he soon gave tokens of his fitness and aptitude for the career which had been marked out for him, alike by paternal forethought and his own inclination. On the threshold of his professional life the younger Brunel reaped advantages that seldom fall to the lot of the engineer in embryo. His father had attained the zenith of his fame, and was now engaged in the conception and amplification of designs in connection with works of an important character. Of these may be noticed the fine suspension bridges then about to be erected on the Island of Bourbon,

and the notable works which were in course of execution at Chatham—these were some of the undertakings that at that period engaged the attention of the elder Brunel, and his son evinced the most eager desire to profit well by the opportunities thus fortunately placed within his reach.

When eighteen years of age, Brunel was assistant engineer, under his father, in the construction of the Thames Tunnel; and the direction of the operations was shortly after taken into his own hands upon his assuming the post of resident engineer of the great undertaking—a position held by him until the stoppage of the works in 1828, when his genius became free to grapple with engineering questions of a less daring, but certainly more useful, character. A favourable opportunity for the exercise of his powers soon presented itself, in a scheme for uniting the banks of the river Avon, forming the boundaries of the counties of Gloucester and Somerset, by means of a suspension bridge. The offer of a premium having been made for the best design for that purpose, the young engineer entered the lists as a competitor, and the result of the competition brought the merits of the successful designer prominently before the country. The gentleman selected as referee, to adjudicate upon the several designs sent in to the committee for carrying out the project, was Mr. Telford, the distinguished engineer, then at the height of his fame, and who had also prepared plans for the work in question. The verdict of the referee was declared in favour of Brunel's proposed structure, and in this way did the clever aspirant after distinction achieve an unequivocal victory over men well known throughout the world as possessing talents that peculiarly fitted them for successfully completing such an important work in engineering as the Clifton Suspension Bridge. Brunel achieved this signal triumph when only twenty-three years of age, and it was the commencement of a lengthened series of professional victories that established

his claims to be regarded as one of the foremost engineers of his generation.

On account of the want of the necessary funds the Clifton Bridge was not completed, but the materials prepared for its construction were afterwards used for a similar bridge over the Thames at London, under the direction of the same engineer. The Charing Cross, or Hungerford Suspension Bridge, was designed for foot passengers only, and crossed the river at a point leading from Hungerford Market to Belvedere Road, Lambeth. The chains were borne by two towers in the river, twenty-two feet square and eighty feet high; the height of the roadway above high-water mark being thirty-two feet. The central span between the towers was six hundred and seventy-six feet six inches. The span of each end arch was three hundred and thirty-three feet. The roadway was supported by single suspension rods, twelve feet apart on each side. The structure was opened for traffic on the 18th of April 1845, and was a memorial of the ability of its contriver for several years after Brunel's decease, until the exigencies of the railway system demanded its removal, and the spot it formerly occupied is now crossed by the bridge connecting the Charing Cross Station and the south bank of the Thames.

The contest connected with the Clifton Bridge project, and Brunel's success therein, brought his superior and original powers under the observation of the capitalists of Bristol, who had already begun to turn their attention to the great question of railway enterprise which had attracted the consideration of commercial men throughout the country. Although the scheme which had brought the engineer to the city was not completed, sufficient proof had been given of his being possessed of those qualities most likely to urge him to the front in the new road to wealth which had been opened out through the determination and energy of George

Stephenson and his son. Through the impressions formed of his ability the aid of Brunel was sought and obtained, with a view to the extension of the railway system to the shores of the Bristol Channel. But ere he became identified with railway engineering, the enlargement of the docks in that locality gave employment to his skill, and enabled him to add to the fame that he had already achieved, by the display of marked capabilities, as an engineer and organiser of labour, in the dredging operations that were conducted under his direction.

When called upon to take his place in the witness-box of a Parliamentary Committee, as a champion of the railway system, Brunel had resolved that the Great Western lines should eclipse all that had preceded them; that the principles of their construction and working should be in keeping with the originality of conception and execution which distinguished their engineer; that their proportions should exceed those of the railroads which had been constructed or devised by the Stephensons, after the model of the Northern waggonways; and that the rate of travelling should be doubled, yet without any sacrifice on the part of the public either in regard to comfort or safety. In accordance with that resolution, the broad seven-feet gauge was fixed upon—a departure from the narrow gauge of four feet eight and a-half inches that was calculated to afford scope for greater engine-power in the haulage of trains, while forming a protective barrier against the entry of the Stephensons into the Great Western territory. To ensure a more equable bearing for his carriages, and thus obviate the jolting inseparable from progression over the earlier public railways, Brunel decided that the rails of his mammoth railway should be laid upon longitudinal timbers, instead of the transverse sleepers, some feet apart, that carried the rails of the narrow gauge lines. The innovation of the broad gauge thus introduced, and sanctioned by the Legislature, however,

led to considerable discussion and much bitterness of feeling between the partizans of the two systems, until the debate was at length terminated by an enactment that practically the narrow gauge should be thenceforward the established width of all new railways constructed in Great Britain.

Without discussing the respective merits of the broad and narrow gauges, or detailing the struggle for supremacy that the two systems evoked, the force of Brunel's influence in the railway world may be credited by noting the lines that he constructed, some of which were the Great Western, with its several branches to Brentford, Hungerford, Oxford, etc.; the Gloucester and Bristol, the Bristol and Exeter, the Bristol and South Wales, the South Devon, the East and West Somerset, the Bucks and Hants, the Oxford and Rugby, the Oxford, Worcester, and Wolverhampton, the South Wales and Forest of Dean, etc.; the Wilts and Somerset, the Oxford and Birmingham, and the Birmingham, Wolverhampton, and Dudley Railways. These works in England extended to an aggregate of eleven hundred miles, and proved the soundness of Brunel's engineering principles as well as the wide scope that he possessed for their exercise.

In the sister country he constructed the Dublin and Wexford, and the Cork and Waterford lines. In Italy, the Florence and Pistoja, and Genoa and Pavia, through the principal chain and valleys of the Appennines. In India, the Eastern Bengal Railway was formed under his direction. But his efforts were not confined to the provision of iron highways for the growing requirements of commerce and travellers, and it would be impossible here to enumerate all the important projects that owed their completion to the engineer's versatile and comprehensive genius. It may be stated, however, that his design for a portable hospital for the Crimea was considered the most perfect and suitable ever devised, and that only the sudden termination of the war prevented the full recognition of the excellence of his

plans for the assuagement of the sufferings of wounded soldiers. The waterworks at Clifton and Chippenham were planned by the engineer, as were also the docks at Sunderland, Bristol, Plymouth, Neath, and Birkenhead, with others that evidence the remarkable industry and ability of their designer.

For a long period Brunel gave studious devotion to the construction of steam vessels, upon a scale considerably larger than had hithertofore been considered possible or convenient. His intimate connection with the shipping interests of the West Coast gave opportunities for testing the practicability of his views, and two vessels were successively built from his designs and under his immediate superintendence. These were the "Great Western," of 1350 tons, and the "Great Britain," of 3500 tons. The success of the splendid steamers, owned by the large ocean companies of this country and others, fully confirms the accuracy of the anticipations held out by the daring nautical engineer. The vast superiority of the "Great Western" over a steam vessel then considered of large tonnage, was demonstrated during an early trial of Brunel's first model ship. The "Sirius," 700 tons, departed from Bristol for New York eight days before the "Great Western" left Cork harbour for the same destination. After having exhausted all her fuel, and consumed wooden articles—such as spare spars, furniture, and a child's doll—in the eager desire to reach port as soon as possible, the "Sirius" landed at New York only seven hours before the "Great Western;" the latter vessel having a hundred and twenty-five tons of coal in her bunkers after her trip across the Atlantic. This gratifying result rendered clear the advantages to be derived from the use of large vessels of great proportionate steam power, as well as the likelihood of more profitable returns for the capital invested, resulting from the expeditious speed and carrying capacity of steamers of that character.

The superiority of the "Great Britain" led to the projection of the Great Eastern Company, and the appointment, in 1852, of Brunel as the engineer of a leviathan steamship, capable of performing, within two months, a voyage to Calcutta and back, without stopping to take in coal. That he fulfilled, in the "Great Eastern," the conditions which he had laid down may not be disputed. Unhappily, one of the engineer's greatest professional successes proved commercially a failure. Prematurely broken down by excessively arduous work, he died on the 15th of September 1859.

Widely different opinions have been expressed regarding his last great undertaking, as well as of other projections that received the influence of his persuasive advocacy. But one opinion prevails as to the impetus that was given to Railway Enterprise, through the strength of his originality and the force of his example. As the pioneer of high speed, Brunel stood for a time almost alone in the engineering world. At length professional rivals found that they must either come up to his standard for the traffic of the country, or allow him to enter their territories and provide for the comfort and convenience of the public, after a fashion peculiarly his own. The champions of the narrow gauge, with its attendant deficiency of engine-power, adopted the former alternative, and gave their energies to the improvement of their locomotives, so as to compete with the more efficient engines on Brunel's railroads. The powerful locomotives constructed for the principal lines of the country, and exhibited at Newcastle-on-Tyne on the centenary of the birth of George Stephenson, prove conclusively that the great object for which the Railway Pioneers struggled and toiled has been accomplished.